PHYSIOLOGY;

OR,

An ATTEMPT to EXPLAIN

THE

FUNCTIONS AND LAWS OF THE NERVOUS SYSTEM; THE CONTRACTION OF MUSCULAR FIBRES; AND THE CONSTANT AND INVOLUNTARY ACTIONS OF THE HEART, THE STOMACH, AND ORGANS OF RESPIRATION,

BY MEANS OF SIMPLE, UNIVERSAL, AND UNVARYING *PRINCIPLES.*

TO WHICH ARE ADDED,

OBSERVATIONS

ON THE

INTELLECTUAL OPERATIONS OF THE BRAIN;

AND ON THE

DIVERSITY of SENSATIONS;

WITH

REMARKS

ON THE

Effects of Poisons;

AND

AN EXPLANATION OF THE EXPERIMENTS

OF

GALVANI AND OTHERS,

ON

ANIMAL ELECTRICITY.

By E. PEART, *M. D. &c.*

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PREFACE.

WITHIN the laſt eight or nine years I have frequently offered my ſentiments to the public on various philoſophical ſubjects. I have rejected the commonly received opinions on the general principles and operations of nature, becauſe they are *abſurd*; but I have never rejected them without firſt of all proving that they are ſo. I have propoſed the principles upon which I have founded my own theory, but not without proving, as far as the nature of the ſubject will admit, that thoſe principles do actually exiſt; and the laws by which they are regulated are deduced from facts which nature every moment preſents to our view.

That the chemical doctrines of M. Lavoisier, and the electrical theory of Dr. Franklin, are founded on *absurd principles*, and are, therefore, *erroneous*, I have *proved* by such arguments as I do not for a moment hesitate to assert, are absolutely conclusive: whatever, therefore, may be the fate of my own theory, *theirs*, to a certainty, *are false*. With respect to my own *principles*, I feel as confident of their existence as of my own; how far I have succeeded in developing the *laws* by which they are governed is another matter;—many of my conjectures may be erroneous, and much remains to be discovered. Confidence, however, may be misplaced; and I have all along declared, and still declare, that I would not for a moment hesitate to *abandon* both my *theory* and *principles* were they once proved to be *fallacious*.

That the theories of Dr. Franklin and M. Lavoisier are *generally adopted* is granted; but, that is *no proof* that they are either *true* or *rational*.

Reason never was, nor now is necessary, to

eſtabliſh an opinion; witneſs the number of doctrines which have been advanced, embraced, and forgotten! neither is the general aſſent of a million any proof of veracity, for no opinion is *too abſurd* to want converts, as is evident in *philoſophy* as well as *religion.*

When I read in a modern publication of celebrity, that venous blood attracts oxygen from the azote of atmoſpheric air, and in the next paragraph that azote attracts oxygen from blood, without any reaſon why or wherefore, can I call it philoſophy? Surely not—the aſſertions manifeſtly contradict each other, and the theory which reſts upon ſuch principles and explanations, appears to me rather *contemptible* than ſatisfactory.

When I am told that the brain ſecretes the *electric fluid*, and that the tranſmiſſion of a portion of the electricity to any particular nervous fibre, cauſes the muſcle to which it is diſtributed, to act—what am I to underſtand?—The ſame philoſopher as being of the Franklinian ſchool,

allows that the brain cannot communicate its poſitive electricity to a muſcle, unleſs *that muſcle* be *negative :* the will, then, inſtead of tranſmitting electricity from the brain, muſt act upon the *muſcle* by rendering it *negative*, and then the electric fluid of the brain ruſhes to the muſcle to reſtore the equilibrium :—but, when the muſcle was *not* in action, it had its uſual proportion of electric power ; how did the will, then, diſpoſe of that natural electric power when it rendered the muſcle negative ?—in ſhort, the opinion is prepoſterous !—The powers of the brain and nerves *cannot* be in an *electric ſtate* ; for it is an undoubted fact that the nerves are conductors of electricity, and that the electric fluid communicated to *any part* of the common trunk of a nerve, will affect *every fibre*, and will excite *every* terminating branch of that nerve ;—but the *voluntary* act of the mind can tranſmit its power to *one ſingle* muſcle *alone*, though the nerves connected with ten thouſand other muſcular fibres were collected into the ſame bundle ſo as together to conſtitute one nerve.

When I am aſſured that the blood by circulating through the arteries to a muſcle, returns by the veins, loaded with powdered charcoal, can I avoid aſking how and where it acquired its charcoal?—And when I am told that the charcoal thus mixed with the venous blood, combines with oxygen gas in the lungs, and forms fixed air,—can I avoid being ſtruck with the ſingularity, that ſimple charcoal can combine with oxygen gas *in* the lungs, at the temperature of 96°, when charcoal *out* of the lungs might be expoſed to the ſame air to eternity, without producing fixed air, unleſs a *much greater* degree of heat were employed!—the charcoal *in* the lungs, then, *cannot* be in the *ſame ſtate* as the charcoal *out* of the lungs; and ſome principle or cauſe is overlooked, which renders the antiphlogiſtic doctrine lame, imperfect, and unſatisfactory.

When I am gravely informed, that the air which almoſt inſtantly congeals the blood of the hardy Siberian himſelf, is formed of 999 parts out of the 1000 of pure, genuine, elementary *Fire,* can I tell which the moſt to admire,—the

abſurd fancy of the firſt conceiver of ſuch an idea, or the *wonderful credulity* of the multitudes, who ſwallow the abſurdity as they do the goſpel!—

When I read, in every periodical work, from the Tranſactions of the Royal Society, down to the humble Review, that the proud *diamond* itſelf is nothing more than cryſtallized *charcoal*,—what can I add—but, that when the readieſt and beſt method of *thus cryſtallizing charcoal*, is clearly pointed out, I will confeſs, that the diſcovery is as *brilliant* as it is now wonderful! wonderful! wonderful!

According to the antiphlogiſtic ſyſtem, carbon, azote, and hydrogen, are three diſtinct principles; but as each of them is capable of *combining* with the *acid* principle and of *ſaturating* it, more or leſs completely; and as they are mutually convertible into each other, as is too well known to the antiphlogiſtians to need inſiſting upon, I heſitate not to affirm, that they are *one* and the *ſame principle*, in different ſtates of pu-

rity, with reſpect to the admixture of other matters, and with different proportions of the *power* by which they are rendered atmoſpheric; and that principle I diſtinguiſh by the name of the *alkaline* or the *antacid* principle; which, therefore, includes both carbon, azote, and hydrogen.—In chemiſtry, thoſe diſtinctions are uſeful; but as my preſent ſubject does not require the ſpecification of the *peculiar* ſtates of the antacid principle, the general term *alone* is employed in the following tract.

But to conſider all the abſurdities and contradictory concluſions of the antiphlogiſtic doctrine, would be an unneceſſary repetition of what I have already more fully accompliſhed. That it is *puerile* and *unphiloſophical*, I aſſert, without the moſt *diſtant fear* of contradiction; and that the Franklinian doctrine of electricity is, if poſſible, ſtill *more abſurd*, I have proved to a demonſtration, on former occaſions; and have, repeatedly, called upon its admirers to defend it—but in vain.

As the ſubject of this tract is chiefly phyſiological, I cannot refuſe myſelf the gratification of acknowledging how much I feel myſelf indebted to my firſt, great, teacher, the juſtly celebrated Dr. Monro, profeſſor of anatomy at Edinburgh. The extent of his knowledge, the ſolidity of his judgment, and the penetration of his diſcernment, impreſſed my mind with that *profound reſpect* which I ſhall retain while I have recollection.

Neither can I forget, nor recollect without cheerfully confeſſing the many obligations that I think myſelf under to Mr. Cruikſhank. His lectures were replete with information, his wiſh to inſtruct was equal to his well-known abilities as a teacher, and his liberality in collecting information from every ſource, was not leſs conſpicuous than his readineſs to communicate it.

For the late celebrated Dr. Hunter my eſteem is ſincere and unabated; his pleaſing manner, ſo much his own, of rendering his ſubject intelligible to every capacity, could not fail of afford-

ing *me* many advantages which I am proud to acknowledge.

There are ſome few philoſophical characters, for whom, though unknown, I have that reſpect which is ſo juſtly their due; and to whom I ſhall take the liberty of preſenting this little tract, as a teſtimony of that eſteem which I feel for men of *ſcience* and *liberality*, howſoever they may differ from me in opinion: the peruſal may afford them an hour's amuſement, and, although I expect *no converts*, ſomething may, perhaps, occur, which may excite their attention, and lead to future improvements.

Upon a ſubject like this, much muſt be left to conjecture; and plauſibility muſt ſtand in the place of demonſtration; it being, perhaps, as impoſſible to demonſtrate, by diſſection, the various ſtructure, connexions, and exact organization of the brain, as it is by the powers of optical ſcience, to detect the intellectual powers themſelves, in the act of thinking.

Strongly convinced as I am of the value of experiments, I ſtill am equally convinced, that diligent attention and accurate reaſoning are equally neceſſary, without which, experiments are labour in vain.

As no ſimple experiment can ſhow why the heart conſtantly beats—how the eye ſees—or the brain perceives and reaſons—I have ventured to collect what facts have come to my knowledge, and from thoſe facts I have endeavoured, by reaſon and analogy, to inveſtigate the reſt, as far as the limited powers of my mind have been able, *directly*, and *extemporaneouſly* to proceed.

I have in no caſe, that I know of, made unfair ſtatements, or drawn unwarrantable concluſions; neither have I propoſed one new principle, idea, or explanation, without giving the reaſon why, nor without being led to do ſo, by ſuch previous arguments and reaſons, as appeared to me ſatisfactory at the time.

I by no means, however, offer this as a finiſhed

work upon the ſubject; the reſult of *twenty years* mature deliberation:—on the contrary, I declare, candidly, that it was *begun* upon, merely as a winter-evening's amuſement, and *finiſhed* in *leſs* than *twice* that number of *evenings*.

I pretend to no order, or method, but what ſpontaneouſly aroſe in the proſecution of my ſubject; nor to any elegance of language, or choice of terms,—thoſe expreſſions *only* being employed which aroſe ſimultaneouſly with the ideas.

In fact, I honeſtly confeſs that I think and write merely for my amuſement—and as I have *no* expectations of making converts to my peculiar opinions, I by no means feel diſpoſed to convert amuſement into *labour*, by the drudgery of *correcting* and *tranſcribing*.

As, however, many of the ideas in this tract are *new*, I preſent them undigeſted and extemporaneous as they are, to thoſe few who have *capability* to underſtand, and *liberality* to conſider them impartially. If they have inclination to attend to

the ſubject, my wiſh *is*, that they may meet with ſomething worthy of *their* attention ;—ſomething which may tend to the improvement of ſcience ; —ſomething which may render their labour not in vain.

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PHYSIOLOGY.

SECTION I.

A general view of the ſyſtem of the human body.

1. THE human body is formed of ſolids and fluids, of different degrees of firmneſs and conſiſtency; and of different properties; as being compoſed of different principles in various proportions, and modes of combination and arrangement.

2. The more ſolid parts are the bones; theſe give form and ſtrength, and conſtitute the baſis to which the ſofter parts are attached; and

by which, parts of the greateſt importance are defended.

3. The matter generally employed in forming and connecting the parts together, is ſimply fibrous or membraneous; of this the veſſels, neceſſary in the ſyſtem, are in a great meaſure compoſed; and by it parts of different kinds are connected together, in variety of combinations.

4. The actions or peculiar functions of the ſyſtem, however, chiefly depend upon the brain and nerves; the heart and blood-veſſels; and the moving, or muſcular fibres.

5. The brain and nerves conſtitute the moſt refined and wonderful part of the general ſyſtem. They are connected together; or, perhaps, the nerves are, in general, merely productions, or elongations of the brain, from which they proceed, as from a common centre; for the purpoſe of conveying the energetic influence of the brain to diſtant parts; where that

influence is neceſſary to produce the functions of the parts to which they are diſtributed, or for the purpoſe of communicating impreſſions made on the nervous extremities to the brain.

6. The heart and blood-veſſels are the next important part of the ſyſtem. The heart is the centre from which the blood-veſſels proceed, or to which they tend;—and the arteries are ſo contrived, as to tranſmit the blood to the moſt diſtant parts, where its influence is required to aſſiſt in the peculiar functions of thoſe parts; while the veins convey it back to the heart, after its influence has been imparted.

7. The muſcular fibres are equally neceſſary in the ſyſtem as the former; for they, alone, poſſeſs the power of motion, or contraction; and, conſequently, without them an univerſal inertia would prevail, and the body would be an immoveable, inactive maſs.

8. The brain and nerves are the only ſentient parts of the ſyſtem. Impreſſions made upon

the nerves, when ſufficiently powerful to excite the attention of the intellectual powers of the brain, conſtitute ſenſations; the affection of the nerve being communicated to the brain, if nothing obſtructs its courſe.

9. The nerves are an eſſential part in the conſtruction of the muſcular, or contracting fibres of the body; for without their preſence and agency, muſcular fibres are inactive.

10. The heart itſelf is a muſcle; and the extremities of the blood-veſſels are alſo muſcular. The heart contains a number of blood-veſſels in its ſtructure; and the muſcular activity of a part, or of the whole ſyſtem, greatly depends upon the preſence of blood; therefore, the blood is requiſite to muſcular action; and, conſequently, the blood-veſſels are an eſſential part in the compoſition of muſcular fibres.

11. Muſcular fibres, therefore, require both nerves and blood-veſſels in their conſtruction.

12. But, a muſcle, though formed of nerves and blood-veſſels, cannot act without the preſence of blood; neither will the voluntary muſcles act, although blood be circulating through them, without the influence of the nerves:—conſequently, a muſcular fibre has both nerves and blood-veſſels in its ſtructure; and its action depends upon the flow of blood by theſe veſſels, and of the nervous influence by the nerves; by the conjoint influence of which blood and nervous energy, the muſcular fibre is made to contract.

From theſe conſiderations then we may conclude—

1ſt. That the brain and nerves, and the heart and blood-veſſels are the chief ſources, of all the powers, by which the different functions of the ſyſtem are produced.

2d. That the nerves and blood-veſſels are eſſential parts in the conſtruction of muſcular fibres.

3d. That the energetic powers of the nerves, co-operating with the blood of the ſanguiferous veſſels, cauſe the muſcular fibres to contract; and,

4th. That all the actions of the body are produced, conjointly by the nervous and ſanguiferous ſyſtems, imparting the influence or fluids they convey to the muſcular fibres, into whoſe compoſition they enter.

SECTION II.

On the brain and nerves; and on the heart and ſanguiferous veſſels, with the blood which they convey.

1. THE brain is compoſed of the cerebrum and cerebellum. They are diſtinct portions; differently conſtructed and ſituated; but wonderfully and intimately connected together.

2. The cerebrum and cerebellum, conjointly, form the medulla oblongata; the medulla ſpinalis, and every nerve in the body; ſo far as it is poſſible to be aſcertained.

3. It is reaſonable then to conclude, that the nerves of the cerebrum are eſſentially different in their nature, or general properties, from thoſe of the cerebellum; conſequently, that the influence, of whatever kind, or nature it may be,

which is conveyed by the nerves of the cerebrum, is eſſentially different from that tranſmitted by the nerves of the cerebellum; for, if the nerves of both cerebrum and cerebellum were of the ſame nature, and conveyed an influence exactly ſimilar in its powers and properties, there could be no reaſon given why they are thus derived from diſtinct origins, and ſo carefully diſtributed to every part from each origin.

4. The ſanguiferous ſyſtem is peculiarly deſtined to convey the blood; which is as neceſſary in the operations of the ſyſtem as the influence of the nerves is.

5. The blood is not an homogeneous fluid; it muſt be formed of thoſe things which are neceſſary, eſſentially neceſſary, to ſupport life; and thoſe eſſential requiſites, are directly the reverſe of each other, in their general properties.

6. One thing indiſpenſably neceſſary to the ſupport of life, is air; atmoſpheric air; or rather the pure air in the atmoſphere. The other eſ-

ſential requiſite is food—if either, or both of theſe be wanting, the functions of the ſyſtem ceaſe, and death enſues: if air be withheld, life is very ſoon deſtroyed; if food be denied, death is equally certain as the conſequence, but at a more protracted period.

7. Air without food, cannot long ſupport the vital powers; neither can food without air: conſequently, they are eſſentially different from each other in their properties and nature.

8. What then is the leading property of the air, ſo neceſſary to ſupport life? There are different kinds of air; but it is the pure, vital, dephlogiſticated or oxygen gas, or air, alone which is required; becauſe thoſe kinds of air which contain it in the greateſt purity and proportion, are the moſt ſalutary; and thoſe ſpecies of air, which do not contain it, are deſtructive, or at leaſt cannot ſupport life.

9. It is then oxygen, or the acid, or acidifying principle, in the ſtate of air, which is one

effential requifite; without which life cannot be fupported.

10. What is the other principle, which muft be of a different nature, (5.) which is equally neceffary to fupport the life of an animal? It is obtained from food of different kinds; chiefly vegetable, animal, or produced from one or both of them; and its fpecific properties may be the beft afcertained, by confidering what it is which affords the moft fpeedy and evident fupport to the powers of life, when taken into the ftomach.

11. We know then that wine and fpirituous liquors produce the moft fudden and invigorating effects upon the ftomach. Spirituous liquors evidently contain an antacid or alkalefcent principle; becaufe, if ardent fpirits or alcohol, which is the moft pure and potent, be expofed to the action of pure air, or oxygen gas, and accended; the air will lofe its aeriform ftate; the alcohol its fpirituous qualities; and water will be the refult of their combination:—but we know that pure air, or oxygen gas, is formed

of the acidifying principle; we know that, in many caſes, when it is deprived of its aeriform ſtate, it conſtitutes an acid; therefore, as it is deprived of its aeriform ſtate by combuſtion with alcohol, and with it forms a fluid which has no acidity; it is evident, that the baſis of the alcohol ſaturates the oxygen, or acidifying principle of the air; and muſt therefore be of an antacid or alkaleſcent nature.

12. Alcohol and vitriolic ether afford immediate ſupport or excitement to the ſyſtem when taken into the ſtomach; and they are little different from inflammable air, or hydrogen gas; as is very evident from their being eaſily converted into inflammable air; and from their forming water when accended with pure air or oxygen gas, as inflammable air itſelf does.

13. It is evident then that ether and alcohol are of the ſame nature; compoſed of the ſame principles; and nearly in the ſame proportions as inflammable air: and the chief difference is, that inflammable air is the moſt diſengaged, and

in an aeriform ſtate; while the ſame principles in alcohol and ether, are combined with ſome other principle, which detains them in a more condenſed ſtate; or, otherwiſe, they only differ in the proportion of that fluid which renders the alkaleſcent, or antacid principle, aeriform.

14. What is the principle which renders oxygen or the acidifying principle aeriform? and what the principle which renders the antacid, or alkaleſcent principle aeriform, ſo as to conſtitute inflammable air? Is it fire or caloric? or is it any one principle common to both pure and inflammable air; which, by acting upon the acidifying and alkaleſcent principles, combines with them, ſo as to render them aeriform? No, it cannot be one principle;—becauſe, when a few grains of oxygen, or of the acidifying principle, are converted into air; thoſe particles are removed far from each other, ſo as to expand into a fluid occupying a much greater ſpace than before; conſequently, each particle of oxygen muſt be ſurrounded with an atmoſphere; and as thoſe atmoſpheres prevent the particles of oxygen from approaching near to each other, they

muſt repel, or reſiſt each other, and cannot have any attraction for each other, ſo as to enable them to combine.

In like manner when the alkaleſcent principle is converted into inflammable air, each alkaleſcent particle muſt be ſurrounded by an atmoſphere, which reſiſts the approach of every other ſimilar atmoſphere; therefore, the atmoſpheres rendering the antacid or alkaleſcent particles aeriform, being ſimilar, have no attraction to each other, by which they can combine. But, if the pure air, or oxygen gas be mixed with hydrogen gas, or inflammable air, they may readily be made to attract each other and combine; leaving the acidifying and alkaleſcent particles united together, in a ſtate of perfect neutrality, conſtituting water.

15. It is evident then, that there are two diſtinct principles, or powers; one of which will convert oxygen, or the acidifying principle, into pure air; and the other will convert the antacid, or alkaleſcent principle, into inflammable air: that the atmoſpheres ſurrounding the

particles of oxygen, have no attraction for each other; that the atmospheres surrounding the alkalescent particles, have no attraction for each other; but, that the atmospheres surrounding the acidifying principle, attract, and will combine, with the atmospheres which render the particles of the alkalescent principle aeriform: in consequence of which combination, the acid and alkaline particles are left, without those atmospheres, combined together, so as to constitute water; and, from the quantity of fire and light, which is produced during the combination, there can be no reason to doubt, that those two atmospheres, by combining together, and quitting their aeriform states, constitute the fire, and excite the light, which appear at the instant of their combination.

16. It appears, then, that the alkalescent, or antacid principle, is an essential requisite to support the functions of the living body; that those substances which contain it in the purest and most abundant state, are the most powerful in supporting the immediate operations of the system; and that all substances, whether animal or

vegetable, which are capable of ſupporting life, contain this principle in ſome ſtate and proportion or other.

17. But, it is not the acidifying principle, or oxygen, ſimply, alone, which is requiſite; nor the pure alkaleſcent principle; nor the two together, which can ſupport the ſyſtem: on the contrary, the acid principle muſt be in the aeriform ſtate, by means of its peculiar power in an atmoſpheric ſtate ſurrounding its particles; and the alkaline principle muſt be attended with its peculiar power, which renders it aeriform, though not uncombined, or ſo abundant as to render its particles in an aeriform ſtate: conſequently, the functions of the ſyſtem require for their ſupport the acid principle rendered aeriform by its peculiar power; and the alkaline principle, combined with certain proportions of that peculiar power, which, in a larger proportion, or in a ſtate of freedom, would convert it into inflammable air.

I have ſo repeatedly inveſtigated this ſubject, and come to the ſame concluſions, in whatever

manner or direction the investigation has been pursued, that I feel the greatest confidence in the veracity of these principles: and, as, upon former occasions, I have found it necessary to apply distinct appellations to the principles in question, for the purpose of more ready and distinct discrimination; so I shall, here, observe the same method.

Oxygen, or the acidifying principle, then, I shall call, for conveniency, the acid principle.

Hydrogen, or the alkalescent principle, I shall distinguish by calling it the antacid, or the alkaline principle; which, also, by partial combinations with the other principle, and the powers in different proportions, forms the different kinds of earths.

That peculiar power, or fluid, or principle, which renders the particles of the acid principle aeriform, by becoming atmospheric around them, I shall distinguish by the title of æther, or the æthereal power; and, the fluid, power, or principle, which,

in an atmofpheric ftate around the particles of the alkaline principle, renders them aeriform; I fhall call phlogifton, or the phlogiftic power.

From the preceding confiderations, then, I draw the following general conclufions:

1ft. That the brain confifts of two diftinct fubftances; of different powers, and properties: the cerebrum, and cerebellum.

2d. That they are intimately connected together, and invariably accompany each other, in all their ramifications.

3d. That every common nerve is connected with the cerebrum and cerebellum; and, therefore, that every nerve is compofed, in fact, of a branch from the cerebrum, and another from the cerebellum.

4th. That every branch of nerve connected with the cerebrum, contains and conveys a peculiar energy, fluid, or power; that every branch

from the cerebellum contains and conveys a peculiar fluid, or power, alſo ; but, eſſentially different in its properties from the former ; and, conſequently, that every common nerve is compoſed of a nervous branch from the cerebrum, and another from the cerebellum ; each of which is ſupplied with its peculiar power, eſſentially different from the other.

5th. That the heart and ſanguiferous veſſels contain and convey the blood ; which is compoſed of two diſtinct principles, with their reſpective powers in chemical combination.

6th. That the blood derives its principles and ſupport, from the atmoſpheric air, conſtantly taken into the lungs ; and from the food repeatedly taken into the ſtomach.

7th. That the principle taken from the air is the acid principle, rendered aeriform by the æthereal power.

8th. That the principle ſelected and acquired

from the food is the alkaline, or antacid principle; combined with a portion of the phlogiſtic power.

9th. That the blood, thus conſtantly ſupplied with the acid principle, with its æthereal power; and with the alkaline principle, with its phlogiſtic power; is capable, by co-operation with the nerves and their reſpective powers, of producing all the functions of life; all the actions and operations of the human ſyſtem.

SECTION III.

On the powers of the brain and nerves; by which they produce their effects upon muſcular fibres.

1. IT has been concluded on probable grounds, (ſect. ii. 2. 3.) that the cerebrum and cerebellum, and their reſpective nerves, are eſſentially different from each other, with reſpect to their general properties; and the fluids, energies, or powers which they contain and convey, when excited to action.

2. What are thoſe fluids, or powers; and from whence are they derived? Certainly from the blood; and the blood acquires them from the air and food, which are ſo neceſſary to ſupport the life and animation of the brain.

3. If a man be deprived of a conſiderable

quantity of blood, he faints; if the loſs be very great, he dies.

If a man be prevented from breathing pure air, the functions of the brain quickly languiſh; the ſenſes and reaſoning powers are ſuſpended; and perfect inſenſibility and inconſciouſneſs uſher in death.

If he be deprived of food, all the powers of the body and mind gradually diminiſh; and a total ceſſation of all the functions of the ſyſtem, or death, is the conſequence.

Air of the pureſt kind without food, cannot preſerve the powers of the brain; and the moſt generous food and exhilarating cordials are applied in vain, to ſupport and excite the faculties of the brain, if air be wanting.

4. It is evident, then, that the functions of the brain and nerves immediately depend upon the blood; becauſe if the brain be not largely

ſupplied with blood, its powers and functions are diminiſhed, or entirely ceaſe.

It is equally certain, that the blood with which the brain is ſupplied, muſt contain both the principles which it acquires from the air and from food; for if the blood be deprived of either, or both of thoſe principles, the functions of the brain are ſuſpended, or deſtroyed. It is evident, therefore, that the brain does acquire from the blood, either the acid principle with its æthereal power, and the alkaline principle with its phlogiſtic power; otherwiſe it ſeparates from the blood the æthereal and phlogiſtic powers, and leaves the acid and alkaline principles combined in the blood.

5. The brain, then, does ſeparate and acquire from the blood, either the two powers; or the two principles with their powers combined with them; becauſe, without a conſtant ſupply of blood its functions ceaſe; and, without a conſtant ſupply of air and food, the blood is incapable of ſupporting thoſe functions.

6. But, the principles which the brain acquires from the blood, are applied to the purpofe of fupporting the actions of the fyftem:—thofe principles, then, are tranfmitted from the brain, along the nerves, to the mufcles. If we confider the extreme minutenefs, or exility of the nervous fibres, which convey thefe powers from the brain; and the rapidity of the motion with which thofe powers are tranfmitted along the nerves; it will appear highly improbable to fuppofe that the acid and alkaline principles themfelves, are propelled along the nerves; and, it is therefore reafonable to conclude, that the brain does, in reality, feparate and acquire from the blood, the æthereal and phlogiftic powers only; completely difengaged from their refpective acid and alkaline principles; which are, therefore, left combined in the blood.

7. We may then reafonably conclude, that the brain and nerves do feparate from the blood the æthereal and phlogiftic powers; that thofe powers, when excited, rapidly flow along the nerves to affift in the neceffary actions of the

parts to which they are diſtributed; that they are diſcharged from the nerves when they produce thoſe actions; that a conſtant ſupply of thoſe powers from the blood is neceſſary to replace the æthereal and phlogiſtic powers expended in thoſe actions; and, that a conſtant ſupply of air and food is therefore requiſite to enable the blood to afford thoſe neceſſary ſupplies to the brain and nerves.

8. As the æthereal and phlogiſtic powers, then, are eſſentially neceſſary to ſupport the functions of the brain; and by being excited to flow along the nerves, produce the various actions of the ſyſtem; and, as the brain and the nerves proceeding from it are evidently of two diſtinct kinds; the cerebrum and cerebellum; it is natural to ſuppoſe, that the cerebrum and its nervous fibres, particularly, ſecrete and convey one of thoſe powers; and the cerebellum and its nerves the other. Two diſtinct powers, or principles, are evidently requiſite to ſupport the functions of the brain; and, as the cerebrum and cerebellum are diſtinct portions of the brain,

there can be no reaſon given why thoſe parts are ſo diſtinctly formed, unleſs it be, that each may ſecrete its diſtinct power, or active principle, from the blood: and, as the medulla oblongata and medulla ſpinalis, from which the nerves proceed, are evidently formed of fibres from both the cerebellum and cerebrum; it is reaſonable to conclude, that every common nerve is compoſed of fibres from both the cerebrum and cerebellum; and, that every fibre is ſupplied with that peculiar power, which is ſecreted from the blood, by that portion of the brain to which it is immediately connected.

I hold it, therefore, perfectly allowable to draw the following concluſions:

1ſt. That the brain ſeparates from the blood the æthereal and phlogiſtic powers; pure and uncombined with the acid, or alkaline principles.

2d. That the brain evidently conſiſts of two diſtinct portions, of different organization, and

form ; and, that the cerebrum ſeparates from the blood, one of thoſe powers only ; and the cerebellum the other.

3d. That the nerves connected with, or ariſing from the cerebrum, contain and convey the ſame power as the cerebrum ſeparates from the blood ; and that the nerves of the cerebellum, only convey that power, or kind of power, which is peculiarly ſecreted by the cerebellum.

4th. That all the nerves being derived from the medulla oblongata and ſpinalis, are formed of diſtinct fibres, from both the cerebrum and cerebellum ; which mutually compoſe and conſtitute the medulla oblongata and medulla ſpinalis.

5th. That every common nerve thus formed, and conſiſting of diſtinct fibres from the cerebrum and cerebellum, does contain both the æthereal and phlogiſtic powers ; the fibres ariſing from the cerebrum, diſtinctly poſſeſſing one

power; while the fibres from the cerebellum diſtinctly contain the other.

6th. That when theſe powers are excited, they flow along the common nerve, to the parts whoſe actions they are concerned in producing; and are there diſcharged from the nervous extremities.

7th. That the brain muſt require a ſupply of æthereal and phlogiſtic powers from the blood, equal to the expenditure in producing the actions of the ſyſtem; and, conſequently, that the neceſſity of air and food to reſtore thoſe principles to the blood, muſt equal the degree of action in the ſyſtem, by which they are expended.

SECTION IV.

On the action or contraction of muscular fibres.

1. MUSCULAR fibres, whether they be subject to the will, or act independently of it, are still of the same nature: their contractions are similar in effect; and, therefore, to be attributed to similar causes.

2. A muscle, subject to the will, or what I shall call, for conveniency, a voluntary muscle, cannot be made to act by volition, if the nerve by which that muscle is connected to the brain, be cut; consequently, the nerves perform an essential part in voluntary muscles.

3. But, as contraction is an effect produced upon a muscular fibre; and as the nerves are essentially necessary in producing that effect, in

voluntary mufcles; fo they muft alfo be effentially neceffary to produce that effect in all fibres, whether voluntary, or involuntary.

4. The nerves, then, form an effential part in the conftruction, and communicate a power, effentially neceffary in producing the contraction of all mufcular fibres, whether voluntary, or involuntary.

5. If a man, in perfect health and vigour, be fuddenly deprived of a large quantity of blood; although the brain and nerves, a moment before, were replete with power and animation; yet, upon that lofs of blood, the power of moving the mufcles will be loft alfo.

If in an animal of any kind, in perfect health and vigour, the arteries fupplying any mufcular part with blood, be cut, or tied; the power of moving that part, or mufcle, will be diminifhed, though the brain and nerves are unaltered and unexhaufted. Confequently, the

presence of blood is essentially necessary to the perfect action of muscular fibres.

6. What is contraction?—In what does the contraction of a muscular fibre consist?—The fibre is shortened; its extremities are brought nearer together:—in fact, the particles of matter, of which the muscular fibre is composed, are approximated; that is, they are attracted nearer to each other.

7. Muscular contraction, then, is neither more nor less than this; the particles of matter, arranged so as to form a fibre, by the influence of the nerves, are attracted nearer to each other.

8. The component particles of a muscular fibre, in their common, or inactive state, are considerably distant from each other: the nerves impart a power, or powers, by which those distant particles are attracted to each other; consequently, their distance must be lessened, and the fibre they form must become shorter.

9. But, as the particles compofing mufcular fibres when not in action, are diftant from each other; the power by which they are rendered attractive to each other muft be extended from one particle to another; fince nothing can act where it is not: confequently, the power communicated by the nerves, muft extend around the component particles of the mufcle, in an atmofpheric ftate; fo, that the atmofphere of one particle may be in contact with the atmofphere of the next particle to it.

10. But, if a power forms itfelf into an atmofphere around a particle of matter, it is evident, that it does not fimply attract that particle fo as to enter into clofe combination with it; but, on the contrary, it merely arranges itfelf around it, in an atmofpheric ftate; therefore, it cannot be fuppofed that two fimilar atmofpheres, thus arranged, can attract each other.

11. It is well known, that the particles of the acid principle, when they acquire atmofpheres, and become aeriform, are not attrac-

tive amongſt themſelves; on the contrary, the atmoſphere ſurrounding each acid particle, acts againſt, or reſiſts the approach of every ſimilar atmoſphere: and, as was before obſerved (ſect. ii. 14) the particles of the alkaline principle, when ſurrounded by the phlogiſtic power, are kept diſtinct and diſtant from each other; conſequently, thoſe atmoſpheres of phlogiſton do not attract each other, nor draw the alkaline particles together.

12. But it has been ſhewn, (ſect. ii. 14) that an atmoſphere of the æthereal power, ſurrounding the acid principle, will attract an atmoſphere of phlogiſtic power, around its antacid principle; and by that attraction they will draw their reſpective particles of acid and alkaline principles into contact; conſequently, by analogy we are led to ſuppoſe, that muſcular fibres are formed of particles of the material principles, ſimply connected together, by ſimple fibrils; and, that the nerves of the two kinds, convey the two contrary powers, to thoſe material particles in muſcular arrangement, each

power communicating with its alternate particles; which powers, when difcharged from their refpective nervous fibrillæ, affume an atmofpheric ftate around the mufcular particles; and, that thofe contrary atmofpheres of the æthereal and phlogiftic powers attract each other, and the particles which they furround, into combination; by which means, the fibres formed by thofe particles, muft be rendered fhorter, of courfe.

I therefore conclude—

1ft. That every mufcular fibre is formed of particles of the material principles, in mufcular arrangement, connected together by fimple fibres.

2d. That thofe particles are alternately connected with the two kinds of nervous fibrillæ; every other particle being connected with the æthereal; and every intermediate particle with the phlogiftic nervous fibrillæ, or the fibres which convey thofe powers.

3d. That when the nerves are excited, they difcharge their refpective powers.

4th. That thofe powers flow to, and furround their refpective particles of matter, in mufcular arrangement; and,

5th. That the æthereal and phlogiftic powers, thus furrounding the alternate particles of the material principles in mufcular arrangement; by their mutual attraction to each other, draw their refpective material particles into contact; and, by that means, the fibre formed by thofe particles is fhortened; and the æthereal and phlogiftic powers being difcharged, combine together, and conftitute fire, or the heat which is produced in animals, by the functions of life.

It is not eafy to conceive, however, how the æthereal and phlogiftic powers, thus fimply communicated to the particles of matter in mufcular arrangement, can form atmofpheres around thofe particles, fo as to extend from one to the

other; when in their common, or inactive ſtate, they muſt be conſiderably diſtant; becauſe, as the æthereal and phlogiſtic powers flow along the nerves, they cannot be in the ſtate of atmoſpheric arrangement.

If, then, the æthereal and phlogiſtic powers, when excited to flow along their reſpective nerves, are ſimply excited, but not atmoſpheric, it is natural to ſuppoſe, that when communicated to their reſpective particles, in muſcular arrangement, they will flow around them in ſtates of ſimple excitation, but not forming any extenſive atmoſpheres:—but, as thoſe particles in muſcular arrangement are diſtant from each other, ſome intermediate powers extending from one particle to another, muſt be neceſſary, to bring them together, and thoſe powers muſt be excited by the nervous powers.

It appears, then, that the nervous powers, when excited, excite other powers; and that thoſe powers draw the muſcular particles together by their attraction to each other.—But, be-

fore we proceed further, it may not be improper to confider what attraction itfelf is; in what circumftances it takes place; and what are the powers and conditions neceffary to produce it.

SECTION V.

On attraction, and the powers by which it is produced.

1. ATTRACTION is the force, or power, drawing two or more bodies towards each other; or holding them together when in contact.

2. Attraction is an effect, produced by an adequate caufe: nothing cannot be adequate to the removal of two bodies towards each other; therefore, whenever two diftant bodies are attracted towards each other, it muft be by an intermediate fomething; poffeffing the power of moving them in thofe directions.

3. Attraction implies, at leaft, two bodies; but does it require that each fubftance fhould

have its attractive power, or is one ſimple attractive principle ſufficient to explain attraction in all caſes? for, as attraction is a ſimple effect, it muſt have a ſimple cauſe; and the ſame effect, in whatever circumſtances it is produced, muſt be referred to the ſame cauſe.

4. Let us then attend to the power or powers by which attraction is produced, in its ſimpleſt and moſt evident ſtate; that is, the power which the magnet poſſeſſes of attracting iron.

5. A magnet poſſeſſes the power of attracting iron at a conſiderable diſtance:—this power is a ſomething in an atmoſpheric ſtate, which extends from the magnet, as its centre, to the iron; as is evident; becauſe it may be deſtroyed by fire, and reſtored again by another magnetic atmoſphere, or by the electric fluid.

6. If a needle be rendered magnetic, what is called its north pole will evidently attract iron at the diſtance of ſix inches; its con-

trary, or ſouth pole, alſo, will attract iron at the diſtance of ſix inches; conſequently, each pole of the needle has an atmoſphere of ſix inches extent from the magnet, and each of thoſe atmoſpheres attracts iron.

7. If another needle be rendered magnetic to an equal degree; its north, or ſouth pole, will, alſo, attract iron to the diſtance of ſix inches; that being the extent of thoſe atmoſpheres.

8. The two needles then have four poles; each ſurrounded with an atmoſphere, attractive to iron at the diſtance of ſix inches.—Are all theſe atmoſpheres the ſame fluid?—If ſo, they will all equally attract or repel each other; becauſe, the ſame cauſe muſt have the ſame effect, when all circumſtances are the ſame.

9. If we take the north poles of the two magnetic needles, and bring them towards each other, they will repel each the other at the diſtance of twelve inches:—then the atmo-

ſpheres of the two north poles, being ſimilar, repel each other;—in like manner, and at the ſame diſtance, the two atmoſpheres of the ſouth poles will repel each other.—It is evident then, that magnetic atmoſpheres, north or ſouth, will attract iron, and repel each other.

10. But—if the north pole of one magnetic needle be brought towards the ſouth pole of the other, they will attract each other, at the diſtance of twelve inches.—It is evident, from the preceding conſiderations, that ſimilar atmoſpheres repel each other:—it is evident, in this caſe, that the atmoſpheres of the north and ſouth pole attract each other: conſequently, they are not ſimilar atmoſpheres; nor can they be formed of the ſame principle, or power.

11. It is evident, then, inconteſtably ſo, that there are two diſtinct powers; that one of them, being excited to arrange itſelf in an atmoſpheric ſtate around one extremity of a needle, the other power arranges itſelf in a ſimilar manner around the oppoſite end; that either atmo-

ſphere will attract iron: that either atmoſphere will repel, or reſiſt, the approach of another atmoſphere, formed of the ſame principle, or power; but, that the two contrary principles will powerfully attract each other, and the needles which they ſurround, into contact, whenever the atmoſpheres formed by them are brought within each other's influence, or extent.

12. On a former occaſion, (ſect. ii. 14, &c.) when conſidering the nature of aeriform fluids, the concluſion was the ſame:—the atmoſpheres ſurrounding particles of the acid principle, and rendering them aeriform, are certainly formed of the ſame principle or power; and thoſe atmoſpheres as evidently repel each other. By repulſion, however, in this and every caſe, I mean no more than the reſiſtance which bodies, fluids, or powers, make againſt each other, when any external force is applied, tending to make them approach nearer than the point of ſimple contaction.

The atmoſpheres ſurrounding particles of the alkaline principle are ſimilar, and repel each other:

But, if an acid and alkaline gas be mixed together, their reſpective atmoſpheric powers will inſtantly attract each other; and drawing the acid and alkaline principles together, will leave them in combination, and diſappear.

It is evident, then, in this caſe, as in magnetiſm, that ſimilar atmoſpheres repel each other: that the atmoſpheres of the acid and alkali attract each other; therefore, they are not ſimilar; and, conſequently, it is evident, that particles of the acid principle are rendered aeriform, by means of a power of one kind, arranging itſelf in an atmoſpheric ſtate around each particle; that the particles of the alkaline, or antacid principle, are rendered aeriform by a power of another kind; that ſimilar atmoſpheres, or of the ſame power, in all caſes repel each other; but, that the atmoſpheres formed by one power, will, in proper circum-

ſtances, attract and combine with the atmoſpheres formed by the other; and by that co-attraction of the two atmoſpheres, their reſpective baſes of acid and alkali are drawn into combination.

13. That the acid and alkaline particles themſelves can have any attractive influence upon each other in the aeriform ſtate, is impoſſible.

A pint of pure air, formed of the acid principle rendered aeriform, weighs, in the common atmoſphere and temperature, about nine grains; —a pint of nitrous acid itſelf, weighs about nine thouſand grains;—a particle of the acid principle then, in an aeriform ſtate, occupies a ſpace one thouſand times greater than when it is in its acid ſtate.

The power, therefore, which conſtitutes the atmoſphere of a particle of the acid principle, and renders it aeriform, is one thouſand times more extenſive, than the particle of acid itſelf

is; and, therefore, nothing can touch or act upon that central particle of acid, without first of all removing, destroying, or passing through this atmosphere, so much more extensive than the space occupied by the particle of acid itself.

When a particle of the contrary, or alkaline principle, is in a similar, or aeriform state, it must be surrounded by an atmosphere of at least equal extent; therefore, a particle of the alkaline principle must be rendered aeriform, by being surrounded by an atmosphere, occupying a space one thousand times greater, than what the particle of alkali itself occupies: consequently, it cannot be possible that the acid and alkaline particles, in the centres of those widely-extended atmospheres, can attract each other; or can be brought into contact, but by the mediation of those very atmospheres themselves, attracting each other, and drawing their respective centres together.

14. The united powers of mechanism can-

not make two atmofpheres of the fame power combine :—they may be compreffed, difplaced, or deranged, by extra force; but the inftant that the external force is removed, the powers refume their ufual ftate of arrangement; and this power of arrangement it is which conftitutes elafticity.

15. Let us now attend to electric attraction.—If a globe of glafs be connected to an infulated conductor; if an infulated rubber be alfo connected to an infulated conductor, and the rubber be made to excite the globe, an electric atmofphere will flow from the globe to its conductor; and at the fame time, an electric atmofphere will flow from the rubber to its conductor alfo.

If two light bodies, fufpended by non-conducting filaments, be brought to the conductor of the globe, each will receive an atmofphere of electric fluid; and the two atmofpheres will repel each other.

If two light bodies, in like manner, be applied to the conductor of the rubber, each will receive an atmosphere, and the atmospheres will repel each other;—similar electric atmospheres, therefore, invariably repel each other.

If one light body, having obtained its electric atmosphere from the globe, be brought near to another, whose electric atmosphere was acquired from the rubber; the two atmospheres will attract each other; will draw the two light bodies together; and will combine and disappear:—these two atmospheres, then, attract each other:—similar atmospheres repel each other;—these, then, are not similar atmospheres:—that is, they are formed of different principles, or powers; and, as was found to be the case with magnetic atmospheres, and aeriform fluids, atmospheres, formed of the same power, repel each other; but, an atmosphere formed of one power, will attract and combine with an atmosphere formed by the other, or contrary power.

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16. I assume, therefore, as an incontestable fact, that there are two distinct powers in nature; which are capable of forming different degrees and modes of connexion with the principles of matter; that when either power is excited by its connexion with matter, it has no attraction to the same power, in a similar state of excitement with other portions of similar matter; but, when the two powers are in similar states of connexion with their respective material principles, and in similar states of excitement, that those two contrary powers will attract each other; and, consequently, that power of mutual attraction will be exerted upon the particles of matter which each is connected with; and will draw, or tend to draw them together.

17. As attraction is, in all cases, the same effect, it must, in all cases, be produced by the same cause: these two distinct powers, then, by connexion with the acid and alkaline principles, become attractive to each other; and by

their mutual co-action it is, that every attraction in nature is performed.

18. I have, on a former occasion, (sect. ii. 17.) given the name of the æthereal power, to that power which is excited to arrangement by the acid principle; and that power which is excited to arrangement by the antacid, or alkaline principle, I have called the phlogistic power; and by these names I shall continue to distinguish them.

19. The æthereal and phlogistic powers, then, by their affinities with matter, and attraction to each other, produce all the attractions, whether chemical, magnetic, or electric; and even the attraction which connects worlds with worlds, and systems of worlds with other systems, so as to form a whole—an universe!—as wonderful as it is extensive!—!—!

These two powers are universally diffused, and present in every part.

They are excited by their refpective material principles, and receive different degrees and kinds of excitement, as thofe material principles happen to be differently circumftanced, and combined with them, and with each other.

They conftitute the atmofpheres which render particles of the acid, or alkaline principle aeriform; they form the magnetic and electric atmofpheres:—fimilar atmofpheres of the fame power always repel, or refift each other's approach.

Æthereal and phlogiftic atmofpheres, in fimilar ftates, attract each other, and their refpective material principles; and when the æthereal and phlogiftic powers combine, in a ftate of excitement, and become difengaged from matter, they conftitute a new compound, which is Fire;—and that fire, acting upon them in their common ftate of univerfal diffufion, frequently imparts to them that motion and excitement which we call light.

20. Aerial, magnetic, and electric atmospheres, therefore, are formed of the æthereal and phlogistic powers, when excited to atmospheric arrangement by the acid and antacid principles, in different states and combinations: the universal attraction which connects worlds into systems, and systems into an universe, is effected by the same two powers, equally and universally diffused, as far as creation extends; in which state of universality, worlds are their exciting centres.

Light itself is no other than an impulsive excitement communicated to those two powers, in their state of universal diffusion; and fire is produced, whenever those two powers, excited by connexion with the material principles, combine together, in that excited state, and recover their freedom; by the particles of matter they draw together, attracting each other to combination.

21. That all these kinds of attraction are performed by the same two powers, is abun-

dantly evident, from a thouſand circumſtances.

The æthereal and phlogiſtic powers in an aerial ſtate, by combination give light; ſo do electric atmoſpheres, and ſo does fire.

Light, by reſiſtance, forms fire: aerial atmoſpheres by combination form fire; ſo do electric atmoſpheres.

Light, fire, or electric atmoſpheres, impart to the alkaline principle the phlogiſtic power; and render its particles aeriform, or inflammable air; and they alſo convert the particles of the acid principle into pure air, by ſupplying them with the æthereal power.

Magnetic atmoſpheres are deſtructible by fire, or by electric powers; and iron may be rendered magnetic by the phlogiſtic and æthereal powers in an electric ſtate; and, in all caſes, if iron be deprived of its phlogiſtic power, it is rendered incapable of exciting the

æthereal and phlogiſtic powers to magnetic arrangement.

22. In ſhort, all atmoſpheres, whether aerial, magnetic, or electric, with their general properties and laws of action, are inexplicable, by the utmoſt efforts of ingenuity, if two powers are not admitted, as producing thoſe different atmoſpheres, by each being excited in a ſtate of ſeparation from the other.—Attraction can only be explained by their coaction, and coincidence; fire by their combination; and light by an impulſive excitement communicated to them in their common ſtate of univerſal diffuſion.

That the ſame two powers, (the æthereal and phlogiſtic powers,) aſſume all theſe ſtates, and produce all theſe effects, is evident, from the convertibility of one ſtate into another, mutually and reciprocally; from the reſemblance that all atmoſpheric arrangements have to each other; from the repulſion which takes place in every kind of atmoſpheric arrangement between

ſimilar atmoſpheres, whether æthereal or phlogiſtic; from the attractive force which is always produced when the two contrary powers combine, whatever be their peculiar ſtate of excitement; from the fire which they commonly form by combination; from the excitement which that fire commonly gives to light; and from the facility with which light may be converted into fire.

23. From the preceding conſiderations I draw the following concluſions:

1ſt. That an æthereal and a phlogiſtic power exiſt, univerſally.

2d. That the æthereal power is capable of being excited to atmoſpheric arrangement by the acid principle; and, the phlogiſtic power by the alkaline principle.

3d. That thoſe principles of matter, in different ſtates of combination and activity, impart

different kinds or degrees of excitement, to the æthereal and phlogiſtic powers.

4th. That two atmoſpheres of the ſame power, in ſimilar ſtates of excitement, conſtantly and mutually repel each other.

5th. That an atmoſphere of the æthereal power, will mutually attract and be attracted by an atmoſphere of the phlogiſtic power, in a ſimilar ſtate of excitement.

6th. That the effect of that mutual attraction is combination; by which the particles of matter thoſe atmoſpheres ſurround are drawn together, if not counteracted by a ſuperior power.

7th. That the æthereal and phlogiſtic powers by uniting in this ſtate of excitement form fire, when diſengaged by the combination of their reſpective material principles with each other.

8th. That light is a progreſſive excitement

imparted to the æthereal and phlogiſtic powers in their common ſtate of general and univerſal diffuſion ;—and

9th. That in that ſtate of general diffuſion, they are excited by worlds, and ſyſtems of worlds, to bind the whole into one grand univerſe; in which their attractive powers are ſo moderated by diſtance, as juſt to counteract the rectilinear tendency of motion; by which a whole is produced ; in which every part is regular in its motion, and undeviating in its circuitous path !

I have ſo frequently conſidered this ſubject in my former tracts, and in ſo extenſive a manner, that I neither think it neceſſary, not feel myſelf diſpoſed to enlarge upon it in this place. There are, however, ſome peculiarities attending theſe two attractive powers, which are too eſſential to be overlooked ; theſe are the ſimultaneous production of ſimilar excitements in the two contrary powers by ſeparation : the power which ſimple

atmoſpheres have of exciting ſecondary or external atmoſpheres; and, the reciprocal changes which take place between the powers of attraction and arrangement; which will therefore be conſidered in the following ſection.

SECTION VI.

On the general laws by which the æthereal and phlogiſtic powers are regulated, in their operations with the material principles, and with each other.

LAW I.

THE excitation of the æthereal and phlogiſtic powers is ſimultaneous.

1. The phlogiſtic and æthereal powers, as already obſerved, (ſect. v. 19.) are univerſally extended; and, conſequently always preſent in their common ſtate of general diffuſion. In that ſtate they have the ſimple excitement of general attraction, by which diſtant maſſes of matter are connected together; conſequently the æthereal and phlogiſtic powers in that ſtate of general excitement attract each other.

2. Whenever iron becomes *magnetic* it invariably acquires two atmofpheres; one at each extremity: the atmofphere at the north pole, or at the fouth pole, repels every fimilar atmofphere; but the atmofphere of the north will powerfully attract that of the fouth pole of another magnet; confequently, as before obferved, (fect. v. 10.) the two contrary atmofpheres are formed of two diftinct powers. But, whenever one atmofphere is excited, the other appears at the fame time, invariably.

3. It appears, then, that whenever the two powers in their common ftate receive an excitement of a more powerful kind, they will affume a new ftate: but, it appears equally evident, that the new ftate of excitement confifts in feparation, as well as excitement; for neither power can affume the ftate of magnetic excitement, at one extremity of a needle; unlefs the other power affumes a fimilar ftate at the other extremity.

4. It appears probable, then, that the æthe-

real and phlogiſtic powers, when combined, are inactive with reſpect to other matters; that when they are ſeparated they are active, and aſſume the atmoſpheric arrangement, and retain that activity till they can again combine; by which combination they draw the material principles with which they are connected, together; which conſtitutes attraction.

5. That this is probable from the conſideration of magnetic atmoſpheres, is evident; and that it is a general law will appear evident from the following obſervations:

6. Whenever *electric* appearances are excited by an electric ſubſtance and its rubber, it is univerſally known, that two atmoſpheres are invariably produced. If the apparatus be properly adapted for the purpoſe, one atmoſphere will flow from the electric to its conductor; and another, at the ſame time, will flow to a conductor connected with the rubber. Theſe atmoſpheres are at all times and in all caſes ſimultaneous.

It has been already ſaid, (ſect. v. 15, &c.) that theſe atmoſpheres are neceſſarily formed of two powers; becauſe, like all other æthereal and phlogiſtic atmoſpheres, ſimilar atmoſpheres repel each other invariably; but, an atmoſphere from the electric, as conſtantly attracts an atmoſphere from the rubber.

7. It is evident, then, that the phenomena of electricity depend upon the æthereal and phlogiſtic powers being excited and ſeparated from each other; conſequently, each aſſumes the ſtate of electric arrangement at the ſame inſtant; and they remain in thoſe ſtates of electric atmoſpheres till they have an opportunity of combining; to effect which combination they draw their reſpective centres together, if nothing prevents, and by uniting loſe the electric properties they had while in a ſtate of ſeparation.

8. Whenever either of the two powers, æther and phlogiſton, is *chemically* excited and ſeparated from the other, that other at the ſame time, becomes equally active, and acquires che-

mical properties and affinities. Thus, nitrous acid confifts of the antacid principle, with an excefs of the acid principle. If it be expofed to the influence of the æthereal and phlogiftic powers in the ftate of light, the acid particles will attract the æthereal power, and excite it to arrangement around them, by which they will be rendered aeriform and conftitute pure air; and, at the fame inftant, the antacid particles will attract the phlogiftic power and acquire a change of colour and properties. Thefe antacid particles do not, indeed, become aeriform with their phlogifton, becaufe there is an excefs of acid ftill remaining to detain them in combination.

So, alfo, when calces of gold, filver, mercury, &c. are expofed to the action of fire, light, or electric powers, when the earthy bafis of the metal acquires the phlogiftic power, which reftores it to its metallic luftre and properties, the acid particles which were combined with it in the ftate of calx, combine with the æthereal power, invariably; fo that both the æthereal and

phlogiſtic powers acquire the excitement of chemical affinities at the ſame time.

9. It is evident, then, that when the æthereal and phlogiſtic powers are ſeparated from a ſtate of ſimple combination with each other, whatever degree or kind of excitement is imparted to the one, the other, by the ſame means, becomes equally and ſimilarly excited; whether it be the magnetic, electric, or chemical arrangement and attraction which they are excited to.

LAW II.

WHEN the æthereal and phlogiſtic powers are ſeparated and ſimultaneouſly excited, they are capable of imparting a ſecondary excitement to the common powers ſurrounding them.

1. When the æthereal and phlogiſtic powers are excited to form *electric* atmoſpheres; thoſe atmoſpheres will diffuſe themſelves upon the ſurface of a conducting body.

2. Thole atmoſpheres are of ſmall extent, as is evident from this, that the two contrary atmoſpheres require to be brought very near each other before they can combine and diſappear; and though they eaſily ſpread upon any conducting ſurface, they cannot communicate themſelves from one body to another, unleſs thoſe bodies approach very near to each other; conſequently, the true electric atmoſphere is of ſmall extent from the ſurface it ſurrounds.

3. If a conductor be rendered electric by a phlogiſtic atmoſphere, although that atmoſphere will not combine with its contrary or æthereal atmoſphere whoſe conductor is at the diſtance of an inch, and conſequently that atmoſphere is not extended half an inch from the ſurface of its conductor; yet it will attract a light body at the diſtance of many inches:—it muſt, therefore, have a ſecondary atmoſphere of ſeveral inches extent, beyond the primary electric one.

4. This, however, is not properly the electric atmoſphere, becauſe it is incommunicable by it-

felf; a light fmall body may be attracted by it, and completely immerfed in it, and may ftill be withdrawn without any electric communication; it is only when the body has been in contact with the real, primary, electric atmofphere, that it acquires a portion of that electric atmofphere, and then is repelled; according to the general law, that fimilar atmofpheres repel each other.

5. If two conductors, one having an electric atmofphere of the æthereal, and the other of the phlogiftic power, be placed twelve inches from each other, thofe two contrary powers cannot combine, becaufe they are not in contact.

If a light body be brought between them, it will be attracted by that atmofphere to whofe influence it is moft expofed; it will be drawn to the furface of the conductor, till it arrives at the primary atmofphere itfelf; it will then be charged, repelled, and attracted to the other conductor; where it will be difcharged, re-electrified with the contrary electric power, and repelled; and fo on, in repeated alternations; till it has dif-

charged the atmoſphere of each, by conveying it to combine with the other; and till the repulſion of one, cannot propel the intervening body within the attractive atmoſphere of the other.

6. It is evident, then, that the two electric atmoſpheres of æthereal and phlogiſtic powers, though of ſmall extent themſelves, have ſecondary or external atmoſpheres which communicate from one to the other, or extend around each to a great diſtance.

It is evident, that each power has its diſtinct ſecondary atmoſphere; becauſe each conductor will attract a light body to itſelf, at a conſiderable diſtance.

It is evident that the ſecondary atmoſphere of each power in an electric ſtate, is different from the ſecondary atmoſphere of the other; becauſe two bodies with ſimilar electric and ſecondary atmoſpheres, repel each other to the extent of thoſe ſecondary atmoſpheres; and, an external or ſecondary atmoſphere ſurrounding the con-

ductor of the electric, will attract the secondary atmosphere surrounding the conductor of the rubber, so soon as those secondary atmospheres are in contact; and at a much greater distance, than that where the primary electric atmospheres came in contact and combine.

7. It is impossible, then, to deny, with any support from reason, that every body in an electric state, has a primary and secondary atmosphere surrounding it: the secondary or external atmosphere, will attract all bodies within its extent; but it is incommunicable, unless the body it attracts be brought in contact with the primary atmosphere; in which case, a portion of that primary atmosphere will diffuse itself to the approaching body, and with it a portion of the secondary atmosphere also; by which the body will be repelled, as having an electric atmosphere, similar in its principles to that of the body from which it was communicated.

8. It is evident, then, when the æthereal and phlogistic powers are separated and excited to

the electric ſtate, that each will flow along conducting ſurfaces near them :—that in thoſe ſtates of electric excitement they are extended to a ſmall diſtance from the conducting ſurface ; and that each will communicate a certain degree of excitement to the contrary powers preſent in their ſtate of univerſal diffuſion.

9. When the æthereal power is rendered electric, it will excite the phlogiſtic power in common diffuſion, to form a ſecondary atmoſphere around it ; at the ſame time, the phlogiſtic power being rendered equally electric, will excite a ſecondary, or external atmoſphere of the commonly diffuſed æthereal power around it : ſo that the æthereal and phlogiſtic powers, when ſeparated and rendered electric, give a peculiar excitement to the powers in the common ſtate of diffuſion, by which they become ſeparated, and form ſecondary atmoſpheres attractive to each other and to matter in general.

Each external atmoſphere attracts the other ; each will attract bodies within its extent, to its

refpective centre; each of them will furround another body to which a portion of its primary exciting atmofphere has been communicated by contaction: each of them will repel a fimilar atmofphere, thus communicated to another body; but, neither of them can pafs to any other body, to which its exciting primary atmofphere has not been communicated; neither can the two external atmofpheres though formed of the contrary powers, and powerfully attractive to each other, combine, and return to their common ftate of diffufion, till their refpective primary atmofpheres by coming into contact, deftroy each others electric properties and arrangement; in which cafe, both primary and fecondary atmofpheres will combine and return to their equal ftate of general diffufion.

10. That the æthereal and phlogiftic powers, when excited to electric arrangement, in ftates of feparation, have the power of exciting the furrounding powers in their common ftate, fo as to form fecondary or external atmofpheres around the feparated powers in the electric ftate, is abundantly evident, from what I have now ad-

vanced; and particularly from the more minute discuffions of the fubject, which I have laid before the public upon various occafions; and that thefe powers in other ftates of excitement have fimilar effects upon the common powers is undeniable.

11. *Magnetifm* is peculiar to iron.—If iron be deprived of its phlogifton, it lofes its power of becoming magnetic. The magnetic atmofpheres are, to a certainty, formed of contrary and diftinct powers in arrangement: that extremity of a needle which is now pointing to the north, may, by the proper application of a magnet, be made to point to the fouth: confequently, either extremity of a needle is equally well adapted to become the centre of either of the magnetic powers in arrangement; and, therefore, the needle is formed of certain principles which are capable of exciting either of the powers to magnetic arrangement; and which principle becomes excited at either extremity, depends entirely upon the circumftances which produce that excitement.

12. The needle, then, throughout its whole extent, is equally attractive to the phlogiftic and æthereal powers; and it only becomes magnetic when its phlogiftic power is peculiarly excited towards one extremity; and its æthereal power to the other, as a conftant and invariable confequence.

13. The needle, then, in its natural ftate, contains a certain proportion of the æthereal and phlogiftic powers, attracted within its fubftance by its component particles.

When it is excited that æther and phlogifton are feparated; and the phlogiftic power is attracted by the particles of the iron at one end of the needle and the æthereal power at the other.

The æthereal and phlogiftic powers are then excited by feparation and by being attracted by the particles of iron conftituting the needle. The needle does not contain more æthereal and phlogiftic power when magnetic, than in its natural ftate; only, thofe powers are feparated;

one being drawn towards one extremity, the other towards the contrary.

The powers thus excited, then, are ſimply diffuſed within the ſubſtance of the iron; and are attracted and excited by every individual particle compoſing that needle; in conſequence of which, they are not diffuſible like the electric powers, which are ſimply excited on the ſurfaces of bodies.

In this ſtate of excitement, then, in which the æthereal and phlogiſtic powers are ſimply diffuſed through the iron and excited by its particles, individually, each power excites its ſecondary atmoſphere; the æthereal power collected and excited at one extremity of the needle, excites the phlogiſton of the common powers, univerſally diffuſed; and the phlogiſtic power at the other extremity of the needle, excites its ſecondary atmoſphere of the æthereal power, in the common ſtate of diffuſion: theſe ſecondary atmoſpheres are extended around each pole; each will attract iron; ſimilar atmoſpheres will repel;

and the two contrary powers will powerfully attract each other. When a bar of iron has been attracted to one pole of a magnet, it cannot be repelled; becauſe the primary magnetic power is not diffuſible; being ſimply excited within the very ſubſtance of the iron, by which it is naturally attracted in a peculiar manner, and from which it is inſeparable; but, on the contrary, it will be attracted and detained, becauſe its own powers are excited to a magnetic ſtate; the phlogiſtic power of the magnetic needle will attract the æthereal power of the iron bar, or needle, to that extremity in contact with it; and its phlogiſtic power will, in conſequence, become equally excited at the diſtant extremity; in conſequence of which, when removed, it will be found to be in a magnetic ſtate alſo: only, that end which was in contact with the æthereal end of the magnet, will be phlogiſtic; and the contrary end will have the æthereal power in magnetic excitement; and thoſe powers, thus ſeparated within the needle, or bar of iron, will each excite a ſecondary atmoſphere around them, at-

tractive to iron and to each other, as in the needle by which it was excited.

14. In *chemical* excitement the æthereal and phlogiſtic powers are equally ſubject to the influence of this law.

We know that the acid and alkaline principles will powerfully be attracted and combined if brought together: attraction, in all caſes, is produced by the ſame cauſe; that cauſe is the mutual co-action, and progreſſive coaleſcence of the æthereal and phlogiſtic powers, in ſimilar ſtates of excitement; the acid and alkaline principles, therefore, in their pureſt, ſimpleſt, or moſt powerful and condenſed ſtates, have *each* its reſpective *power* chemically excited around it to a ſmall extent; and thoſe powers by mutual attraction, draw their reſpective principles into combination, and detain them there.

If theſe two principles be ſeparated, the power chemically excited by each principle, will, then, attract a *ſecondary* or *external* atmo-

ſphere, and aſſume the aeriform ſtate ; unleſs one or both be ſtill detained, or attracted by other principles in a more condenſed ſtate.

Thus nitrous acid, when ſeparated from its combination with the antacid, or alkaline principle in various ſtates, and by various operations, excites an external or ſecondary atmoſphere, and forms, by that means, pure air; and inflammable air is in many operations produced, when the alkaline principle is ſeparated from the acid principle, and excites an external atmoſphere of the phlogiſtic power. The calx of mercury is reduced in cloſe veſſels, by a degree of heat ſufficient to remove the particles of the antacid principle, or earth of the mercury, from the acid principle, ſo as to deſtroy their attraction, by ſeparating them beyond each others extent; in which caſe, the acid particles excite an æthereal atmoſphere, and form pure air; while the antacid particles of the mercury excite the phlogiſtic power; which they attract in ſuch proportion as to reſtore them to their metallic ſtate of pure mercury.

It is in numberlefs inftances evident, that the two material principles are capable of affuming various ftates; fometimes being condenfed into the ftates of powerful acids, or alkalies; at others being expanded into aeriform fluids; and frequently being in various intermediate ftates, as they happen to be combined together, in greater or lefs proportions: it is evident, therefore, that thefe principles, at fome times, poffefs the powers in ftates of fimple chemical excitement; and at others, that they acquire extenfive atmofpheres and expand into air; in which ftate, the different principles are feparated and rendered individually aeriform. Confequently, it is reafonable to fuppofe, that when the æthereal and phlogiftic powers are *chemically* excited, they form atmofpheres of fmall extent around their refpective material principles, attracting them together; but if they be feparated, each power, at the fame time, excites a *fecondary* atmofphere around it, to a confiderable extent, by feparating and attracting the common powers, at all times prefent; by which, each principle will be rendered aeriform, unlefs circumftances forbid.

15. I have entered minutely and largely upon this ſubject in my Elementary Principles of Nature; and have given my reaſons for concluding, that the ſimple particles of matter are homogeneous: that every particle of matter is connected with and ſurrounded by an atmoſphere of one, or other of the powers, of ſmall extent:—that a particle of matter with an atmoſphere of æthereal power, in chemical excitement, forms a particle of the alkaline principle; that particles of matter with atmoſpheres of *phlogiſton*, chemically excited, form the acid principle; that the acid and alkaline principles thus formed mutually attract each other to chemical combination; and, that if they be ſeparated from combination with each other, each particle, then, excites a ſecondary atmoſphere of conſiderable extent; which, if not interrupted, renders the two material principles aeriform. In theſe ſtates, ſimilar atmoſpheres repel; and the contrary powers, or atmoſpheres, mutually attract each other to combination.

16. I think it allowable, then, to conclude, when the æthereal and phlogiſtic powers are

excited, by contact with matter, to aſſume either electric, magnetic, or chemical arrangements and properties, that they form, ſimply excited atmoſpheres, of *ſmall* extent; differing in the different kinds of excitement: that thoſe ſimple atmoſpheres of the two kinds, whether electric, magnetic, or chemical, are attractive to each other; that if they be ſeparated ſo as to be no longer within each others influence, each power, whatever be its ſtate of excitement, immediately excites a *ſecondary atmoſphere*, of much *greater* extent around it; that ſimilar atmoſpheres of the ſame power, in all caſes, repel; and the contrary powers in ſimilar ſtates of excitement, are attractive to each other.

LAW III.

THE æthereal and phlogiſtic powers when ſeparated and excited by the contact and influence of material principles, acquire two tendencies or properties; each power is excited to arrangement around its re-

ſpeƈtive material principle, and at the ſame time each is excited to be attraƈtive to the other. Theſe properties reciprocate with each other; ſo that as the contrary material principles attraƈt each other to combination, their attraƈtion to their reſpeƈtive powers in arrangement diminiſhes or ceaſes; and as the material principles become ſeparated from each other, they exert their attraƈtive influence upon their reſpective powers which they take into arrangement; which arrangement is more or leſs perfeƈt and extenſive as thoſe material principles are more or leſs perfeƈtly ſeparated from each other.

1. When the æthereal and phlogiſtic powers are excited to the *eleƈtric* ſtate, they ſimply attraƈt the eleƈtric ſurface to the rubber: the inſtant that thoſe contiguous ſurfaces of the excited eleƈtric and rubber, are ſeparated, the ſimple eleƈtric atmoſpheres are *ſeparated* alſo; and then each excites its *ſecondary* atmoſphere to extenſive arrangement around it. If thoſe ſecondary or external atmoſpheres are permitted to draw their repeƈtive internal atmoſpheres into contaƈt, ſo ſoon as thoſe primary atmoſpheres

attract each other into combination, the excitement of arrangement ceaſes; and the two external atmoſpheres return to their common ſtate.

2. It is evident, then, that when the combination of the primary electric powers is deſtroyed by ſeparation, each power exerts its property of arrangement, and acquires an external, extenſive atmoſphere; and that when thoſe primary atmoſpheres can again combine, their properties of exciting the arrangement of atmoſpheres around them ceaſe, and thoſe atmoſpheres become diſengaged.

3. As the æthereal and phlogiſtic powers in the electric ſtate of excitement, form merely ſuperficial, diffuſible atmoſpheres, it is evident that in thoſe ſtates they have no peculiar attraction, confining them to the ſurfaces they ſurround; when, therefore, the two powers, forming thoſe primary ſuperficial atmoſpheres, combine, they deſtroy each others electric properties, and atmoſpheric arrangement; and with

their ſecondary atmoſpheres return to their uſual mode of exiſtence.

4. In *magnetiſm* the ſame law prevails. Iron ſtrongly and peculiarly attracts both the æthereal and phlogiſtic powers, and they each other:— in this ſtate of combination, they have *no* atmoſpheres. If the æther and phlogiſton be *ſeparated* by magnetic excitement, the moment that their attraction of combination ceaſes to operate, their attraction of arrangement takes place, and each power acquires an extenſive atmoſphere: and the inſtant that the æthereal and phlogiſtic powers in the magnetic ſtate of excitement in the iron, combine and return to their uſual or natural ſtate of equal diffuſion through the iron by that combination, their powers of arrangement and of exciting external atmoſpheres ceaſe.

5. Magnetic atmoſpheres are not diffuſible like the electric, becauſe the primary atmoſpheres of the æthereal and phlogiſtic powers are excited by the attraction of the particles of the iron to thoſe powers in a ſtate of ſeparation;

thofe primary magnetic atmofpheres, therefore, cannot remove from their refpective particles of the iron, neither can they combine together in any other manner, than by attracting and mutually being attracted together, in a ftate of equal diffufion throughout the fubftance of the iron; they are effential to the iron; they never leave it; they are always attracted by it either fingly or combined; and it is only when *feparated* that they acquire the power of exciting *external* arrangements, of the powers, in the ftates of magnetic atmofpheres; but their power of exciting the contrary powers to external arrangement *ceafes*, the inftant that they can *combine* and return to their ufual ftate in the iron.

6. In *chemical* excitements of the æthereal and phlogiftic powers this law conftantly is obferved. The acid and antacid principles are attractive to each other, by which attraction they will *combine* in a ftate of neutrality: but, whenever they are *feparated*, the acid principle will immediately excite the *æthereal* power, which is always prefent in fome ftate or other, to at-

mofpheric *arrangement*; and at the fame time the antacid principle will excite the phlogiftic power.

7. As chemical excitement is produced by the particles of matter in their pure ftate, in contact with either the æthereal or phlogiftic power, that ftate of excitement and combination cannot be deftroyed; for as matter in different ftates enables the two powers to affume different degrees and kinds of excitement, it is reafonable to fuppofe, that when fimple matter and either of the two powers are immediately in contact, they will produce an excitement, which nothing can overpower; and, confequently, which cannot be deftroyed.

8. Matter with the æthereal and the phlogiftic powers, fingly, in chemical combination or excitement, thus conftitutes the two unalterable principles, of acidity and alkalinity:—thefe will powerfully attract each other to combination; but, if they be feparated, the acid principle will excite the æthereal power to arrangement around it; and

the alkaline principle will acquire the property of exciting phlogifton to arrangement around it.

9. When the æthereal and phlogiftic powers in fimple chemical excitement, by contact with matter, are combined with each other, perfectly, they have no power of attracting other powers to fecondary arrangement. If they be feparated, the property of exciting the other powers to arrangement, fingly, around them, inftantly takes place: but, if the two principles again be brought into perfect combination, the power of exciting external atmofpheres ceafes; and the fecondary atmofphere furrounding each principle, will become difengaged, and will therefore combine with the other. For example, either the acid or the alkaline principle, if they be in a ftate of feparation, will attract an atmofphere of the contrary power, and become aeriform: but, if the acid and alkaline airs be mixed together, thofe atmofpheres will draw the acid and alkaline principles together: when thofe principles combine, they no longer can excite, or attract their re-

pective powers in arrangement, which therefore become disengaged, and no longer atmospheric.

10. The acid and alkaline principles, then, have a strong attraction for each other; but, if they are prevented from combining, or are separated, they will attract their respective powers into atmospheric arrangement: so that each material principle has *two* modes of becoming saturated; the first is by *combination*, with its contrary material principle; and the second is, by exciting the contrary power, or the power to which each has an affinity, to assume the *atmospheric arrangement* around it.

11. But, as the attraction of combination diminishes, the power of exciting atmospheric arrangement gradually increases; for if a rod of iron be once passed over by either pole of a magnet, the natural principles of the iron will be imperfectly separated, and they will excite a secondary atmosphere of *small* extent; but, if by repeatedly drawing the magnet over the iron, the native powers of the iron be com-

pletely ſeparated, each power will then excite an *extenſive* atmoſphere around it.

So alſo in electricity; if the common powers be imperfectly excited and ſeparated, they will excite ſecondary atmoſpheres of ſmall extent; but, if by continued friction between the electric and its rubber, the two powers be entirely ſeparated, each will excite its ſecondary atmoſphere to an extenſive arrangement around it.

The ſame law being univerſal, muſt take place in every kind of excitement of the two powers; conſequently, in the chemical excitement, it is ſufficiently evident; for when the acid principle is diſengaged from the alkaline principle, it excites the æthereal power to form a complete atmoſphere around it, by which it is converted into *pure air*; if it be ſlightly attracted to combination by the antacid principle, which is not in a ſtate, or in ſufficient quantity to perfectly combine with it, its æthereal arrangement will be diminiſhed, as in *fixed air*; and, if it be more intimately attracted to combination by the

antacid principle, which ſtill is not in a ſtate or proportion to perfectly combine with it, it will retain a ſtill leſs proportion of its æthereal arrangement and conſtitute an *acid* in a ſtate of liquidity.

12. In fact, the alkaline and acid principles, with their reſpective æthereal or phlogiſtic powers, may be combined in ten thouſand various ſtates and proportions; in conſequence of theſe properties of combination and arrangement of the æthereal and phlogiſtic powers, when chemically excited by matter, being *reciprocal*, one *diminiſhing* in power as the other *increaſes.* And the chief agent by which the material principles are ſeparated, when combined by chemical attraction, is fire; concerning which a few words may not be improper.

ON FIRE.

LAW IV.

WHEN the æthereal and phlogiſtic powers are excited to ſecondary arrangement, by the influence of matter, and in that ſtate of excitement, combine, and in that excited ſtate of combination become diſengaged, from matter, they will retain the power of, or the tendency to, arrangement around matter; and will, thereby, inſinuate themſelves into the atmoſpheres of any bodies near them.

1. We know nothing of the æthereal and phlogiſtic *powers,* but when they are connected with matter.—Unconnected and unexcited by matter, they are perfectly unknown to us; and it is only when excited by matter, that they become poſſeſſed of ſenſible powers and activity.

2. We know that the material principles have the power of exciting thoſe powers to arrangement;—and we know that the æthereal power in arrangement will attract the phlogiſtic power in a ſimilar ſtate.

3. If a particle of the acid principle with an æthereal atmoſphere, be brought near to a particle of the antacid principle with a phlogiſtic atmoſphere, the two powers will attract each other by combining; and they will alſo powerfully attract their reſpective material principles, ſo as to draw them into contact; conſequently, the æthereal and phlogiſtic powers when excited to *attract each other*, are alſo *attractive* to the *material principles.*

4. The two powers, then, when excited by matter, are excited to arrangement around it: while they remain in arrangement, they are attractive to each other: being ſeparated from matter, and retaining their excitement, they eagerly ſeek for matter around which they may arrange themſelves; therefore, when the æthe-

real and phlogiſtic powers are chemically excited by matter, and combine and become diſengaged from that matter, in that excited ſtate, they have a powerful tendency to *reſume* their atmoſpheric ſtate around matter.

5. When the æthereal and phlogiſtic powers are ſeparately expoſed to the influence of the material principles, they are excited by that influence to become attractive to matter, and to each other, at the ſame time:—their attraction to matter is the attraction of arrangement, by which either of the powers becomes atmoſpheric; and their attraction to each other is the attraction of combination.

6. If, then, the two powers, thus excited by the influence of matter, be combined, and become ſuddenly diſengaged, ſtill, *retaining* their excitement, they muſt ſtill be both attractive to each other and to *matter*, as thoſe two tendencies are ſimultaneous and inſeparable; conſequently, the two powers will have a tendency to attract matter, and to *recover* their ſtate of *ar-*

rangement; they, therefore, as ſoon as diſengaged from their former principles, powerfully inſinuate themſelves between particles of matter near them, whatever be their ſtate of exiſtence; they will arrange themſelves around thoſe particles, or will enter into arrangement with the powers already connected with that matter; conſequently, the powers connecting thoſe material principles together, by this acceſſion of the diſengaged powers, in the ſtate of excitement, will be extended in their arrangement; the particles they ſurround will not be ſo cloſely combined as before, hence, the *expanſion*; and, being leſs powerfully attracted together, by being more diſtant, they will become more liable to decompoſition.

7. It is not conſiſtent with my preſent plan to go over the ground that I have before repeatedly trodden; I ſhall not, therefore, extend my obſervations, but only ſay, that fire is formed of the æthereal and phlogiſtic powers, in an excited ſtate, combined together, and becoming diſengaged from the material principles by which

they were excited; as when pure and inflammable airs are exploded together, the æthereal and phlogiſtic powers attract each other, till the acid and antacid principles come in contact, and combine; when the æthereal and phlogiſtic atmoſpheres become diſengaged in their excited ſtates, attracting each other. In this ſtate of excitement, they form *fire*; and have a tendency to *arrange* themſelves around *matter*, as well as to attract each other; and, therefore, will *attach* themſelves to any kind of matter near them. If the calx of mercury be that matter, the excited æthereal power will attract and arrange itſelf around the particles of the acid particles, and convert them into pure air; while the excited phlogiſton will attach itſelf to the earth of the mercury, and reſtore it to its metallic ſtate, if there be fire enough to *ſeparate* the earth and acid.

8. If fire paſs into ice, it will extend the arrangement of the powers attracting the acid and antacid principles forming the ice, till they are too extenſive to retain the material

principles any longer in ſolid combination; and, if the quantity of diſengaged æther and phlogiſton, in the igneous ſtate of excitement, be great, they will ſtill continue to arrange themſelves around the material principles, till thoſe principles become too diſtant to attract each other any longer, ſo as to prevent the full and perfect atmoſpheric arrangement from taking place, when the whole is converted into vapour.

From what has been thus advanced, in a general manner, upon a ſubject of ſuch great importance and extent, I draw the following general concluſions:

1ſt. There are *two material principles* which conſtitute the baſes of all bodies, ſolid, fluid, or aeriform; which I call the *acid* and the *ant-acid*, or *alkaline* principles.

2d. There are *two powers* univerſally diffuſed, which I call the *æthereal* and *phlogiſtic* powers;—they are eſſentially diſtinct from mat-

ter, and, by co-operation, they produce *attraction*, which imparts motion to matter.

3d. The acid principle has a peculiar affinity with the æthereal power; by which, that power is excited to arrange itſelf in an atmoſpheric ſtate, around the acid principle.

4th. The antacid principle has a peculiar affinity with the phlogiſtic power; exciting it to atmoſpheric arrangement around it.

5th. The *ſimple* particles of matter impart to the two powers the excitement diſtinguiſhed by the peculiar properties which we call *chemical.*

6th. Particles of the material principles, in different ſtates, with reſpect to the powers connected with them, or their connexion with each other, give to the æthereal and phlogiſtic powers *different* kinds of excitement; the chief of which are the *electric*, *magnetic*, and

common excitement, or that of univerſal expanſion.

7th. Whenever the powers, in their common ſtate of diffuſion, are ſeparately excited to any particular ſtate, they become *atmoſpheric*; but, an atmoſphere cannot be formed by one power in any ſtate of excitement, without the other power, at the ſame time, aſſuming a ſimilar ſtate and properties.

8th. When either power is excited to any ſtate of arrangement around matter, it *repels*, or reſiſts the approach of another atmoſphere of the ſame power, in a ſimilar ſtate of excitement, as ſoon as thoſe atmoſpheres come into contact.

9th. When an atmoſphere of the æthereal power, in any ſtate of excitement, comes in contact with a phlogiſtic atmoſphere, in a ſimilar ſtate of excitement, they *attract* each other to combination; and by that power of combi-

nation, they draw the particles of matter which they reſpectively ſurround, into combination alſo.

10th. When the two powers are excited by the influence of matter, to aſſume the atmoſpheric ſtate, in any degree or kind of excitement, ſo ſoon as thoſe excited powers are ſeparated, each becomes capable of exciting a *ſecondary*, or *external* atmoſphere, of conſiderable extent, around it; which it acquires from the powers in their common ſtate of general diffuſion; each power in its ſtate of excitement, attracting the contrary power to become atmoſpheric around it.

11th. Thoſe external atmoſpheres, like their primary ones, reſiſt the approach of ſimilar atmoſpheres, nearer than the point of contact; and, a ſecondary atmoſphere of the æthereal power, attracts the ſecondary phlogiſtic atmoſphere to combination.

12th. Secondary atmoſpheres are entirely

pendent upon their primary atmoſpheres, and can neither permanently combine, nor become diſengaged, till the primary atmoſpheres of the two contrary powers come in contact, and combine; in which caſe, the contrary external atmoſpheres will regain their freedom.

13th. Each power, by the influence of matter, acquires an attraction of *arrangement* around matter; and an attraction of *combination* to the contrary power in a ſimilar ſtate.

14th. Thoſe attractive tendencies *reciprocate* with each other; ſo that, as the attraction of combination, between the primary atmoſpheres, or the contrary material principles, increaſes; their power of exciting external atmoſpheres into arrangement, diminiſhes; and *vice verſa*.

15th. If the two powers in a ſtate of powerful excitement, by the influence of matter, combine, and become *diſengaged* from the matter by which they were excited, ſtill, *retaining* their excitement by being in combina-

tion, they form *fire*; and, as one invariable condition of excitement is to render the *powers* diſpoſed to attract matter and *arrange* themſelves around it, as well as to attract each other, thoſe powers in their excited ſtate, conſtituting fire, will powerfully tend to attract matter and *arrange* themſelves around it, ſo as to recover that ſtate which was eſſential to their production, and is alſo eſſential to their excited ſtate.

16th. If the æthereal and phlogiſtic powers excited by matter, by drawing their reſpective material principles into contact, regain their freedom, and in powerfully excited ſtates combine together, they will form fire; and if abundantly copious, will have ſo ſtrong a tendency to arrangement around matter, as to overpower the attraction of combination by which the particles of ſurrounding bodies are held together.

17th. As the powers form atmoſpheres of different extent, and as their degree of excite-

ment is proportionate to the extent in an *inverse ratio*; thoſe powers may combine together in different ſtates of excitement; and, conſequently, the *fire* which they form by that combination may be in *different* ſtates of excitement alſo, and its powers of action upon matter in various degrees of *intenſity*.

18th. The æthereal and phlogiſtic powers, in their common ſtate of equal and *univerſal diffuſion*, are capable of being excited by thoſe powers in certain ſtates of peculiar excitement from matter; and particularly when they combine together in ſuch ſtates of high excitement as to form fire, particularly active:—the common principles thus excited, tranſmit that excitement in all directions, in rectilinear progreſſion, if not interrupted; which progreſſive excitement conſtitutes *light*.

19th. If the lucific excitement paſſes near to the ſurface of a body, it is drawn out of its rectilinear courſe, towards the body; and its progreſſion afterwards is not parallel with the

direction in which that excitement is propagated, by those powers, not so near to the surface of the intervening body.

This fact powerfully corroborates the preceding observations and positions; it proves that *all* bodies, being composed of the material principles, excite the common powers to *atmospheric arrangement* around them, in some state or other; though those states are not so strikingly evident as the chemical, magnetic, electric, and gravific states of arrangement; and it likewise proves that the powers excited by matter *are* capable of exciting *secondary* atmospheres around them.

20th. When the common powers propagate this lucific excitement, to atmospheres, connected with matter, which *attract* these powers; by that attraction, the lucific excitement is converted into the attraction of combination; the æthereal and phlogistic powers, therefore, combine, by this influence from matter and constitute fire; having acquired the tendency

to arrangement with matter, at the ſame time that they became attractive to each other, by the influence of the matter which arreſted them in their lucific ſtate of excitement.

Having thus taken a general view of the powers and principles which nature employs in her operations, and the common laws by which they are invariably governed, when co-acting with each other; I ſhall now reſume the ſubject of the 4th ſection.

SECTION VII.

On muſcular contraction.

1. THE reſults of the inveſtigations in the firſt four ſections, were—

That there are two material principles; the acid and antacid principles; of which muſcular fibres are formed.

That there are two powers, having each its affinity to one of the material principles; one the æthereal, the other the phlogiſtic power.

That thoſe two powers, when excited by connexion with the material principles, are capable of atmoſpheric arrangement, and are attractive to each other.

That the brain is formed of two diſtinct portions; the cerebrum and cerebellum.

That every complete or common nerve is formed from, or connected with, both the cerebrum and cerebellum.

That the cerebrum ſeparates one of the powers from the blood; and the cerebellum the other.

That every complete nerve being connected with both the cerebrum and cerebellum, is compoſed of nervous fibres from each; therefore, every common nerve conveys both the æthereal and phlogiſtic powers, by fibres, diſtinctly extended, from each portion of the brain.

That the powers conveyed by the nerves, are eſſentially neceſſary to the production of muſcular contraction.

That the blood, alſo, is eſſential to the due action of a muſcle.

That the blood requires conſtant ſupplies of the acid principle with its æthereal power; and of the antacid principle, with its phlogiſtic power.

That the brain and nerves derive their reſpective powers from the blood; and their functions ceaſe, when the blood is exhauſted of thoſe powers.

That the muſcles themſelves require the preſence of blood, duly ſupplied with its material principles and powers, to enable them to act with effect.

That muſcular fibres are formed of particles of the material principles, ſingly arranged, and ſimply connected together, by fibrillæ of common and ſimple conſtruction.

That the particles in *muſcular arrangement* are, in their common inactive ſtate, conſiderably diſtant from each other.

That every other material particle is connected with a ſimple nervous filament, conveying the *phlogiſtic* power from one portion of the brain; while every intervening or alternating particle, is connected with a ſimple nervous filament, conveying the *æthereal* power from the other portion of the brain.

That the flow of theſe *two diſtinct powers* to their reſpective particles of matter, thus alternately arranged, with the aſſiſtance of the blood, produces muſcular contraction, by *attracting* thoſe alternate particles into contact; and,

That the æthereal and phlogiſtic powers, thus combining, and becoming *diſcharged* from their reſpective nerves, conſtitute *animal heat.*

A difficulty then occurred; as the powers flowing along the nerves could not be in an atmoſpheric ſtate, and as the material particles in muſcular arrangement muſt be conſiderably diſtinct, when not in action, how were we to account for thoſe powers becoming ſo extenſively atmoſpheric around the material particles, as to extend from one to the other; which is neceſſary to enable them to draw thoſe particles into contact?

That difficulty I ſhall now attempt to ſurmount, by explanation.

2. In the 6th ſection, when conſidering the peculiar properties of the material principles, and the æthereal and phlogiſtic powers, in certain ſtates of co-action, I endeavoured to prove, from various obſervations and facts, that it is an invariable law, when the two powers are excited and ſeparated by the influence of the material principles, that each power in its excited ſtate of ſeparation, will form an atmoſphere of ſmall extent around the matter it is immediately con-

nected with; and, in thofe ftates, that each power will alfo excite an *external* atmofphere of greater extent around it, by communicating a *fecondary* excitement to the common powers, at all times exifting, in fome ftate or other, around them.—This was particularly confidered and explained as the fecond general law, and arguments were brought to prove that it invariably takes place whether the powers be excited to the chemical, magnetic, or electric ftates of arrangement; the kind of excitement depending upon the peculiar ftate of the material principles exciting them.

3. A nerve, then, fupplying a mufcle, conveys both the æthereal and phlogiftic powers, from the cerebrum and cerebellum; when it arrives at the mufcle, its æthereal power paffes by a diftinct filament to one material particle in mufcular arrangement, and its phlogiftic power by another nervous fibrilla, to another particle, the next we will fuppofe in fucceffion, but confiderably diftant; a number of thefe parti-

cles, in alternate arrangement, forming a muscular fibre.

4. These two powers are separate, and *excited* by the vital or animating powers, when they flow along their distinct fibrillæ; because, when not excited, they do not flow to the particles in muscular arrangement.

5. These powers distinctly excited, and distinctly flowing to their respective particles in muscular arrangement, will, so soon as they are communicated to those particles, *diffuse* themselves around them in the state of small atmospheres highly excited; and each will, therefore, by the common law which always takes effect in similar circumstances, excite to secondary arrangement, a more extensive atmosphere of the contrary power; which external atmospheres the two nervous powers meet with in the blood, so necessary to their due effect.—Those *secondary* atmospheres will, therefore, *attract* each other; they will draw their respective primary atmospheres into *contact*; and

with them the particles of *matter* in *muſcular arrangement,* which they reſpectively ſurround :—by that combination, the contrary powers will deſtroy each other's excitement and arrangement, and will combine and form fire; which diffuſing itſelf into the blood preſent, conſtitutes that degree of *heat* peculiar to *animal life.*

6. The excitement which is given to the æthereal and phlogiſtic *powers* by the *vital* or *animating* principle, then, greatly reſembles the electric excitement of the ſame powers.—In both ſtates the primary excited powers form atmoſpheres of ſmall extent; in both ſtates, thoſe atmoſpheres, when ſeparated from each other's influence, acquire extenſive atmoſpheres of the contrary powers around them, by ſecondary excitement;—in both ſtates, thoſe ſecondary atmoſpheres around the two different powers, attract each other, and, by that attraction, draw the primary atmoſpheres, and the material particles they ſurround, into contact; and in both ſtates, when the two primary

atmoſpheres combine, they quit their atmoſpheric ſtates and properties, and leave their reſpective material particles *deprived* of their *attractive* influence; to which particles they never had more than a ſlight, ſuperficial attachment, as being communicated to them, and not excited by them.

7. Greatly as the vital and electric ſtates of excitement, communicated to the æthereal and phlogiſtic powers, reſemble each other, ſtill, however, they have their differences; and one peculiarity particularly marks the diſtinction between them; which is, that whenever the æthereal and phlogiſtic powers are excited to the electric ſtate, and ſeparated, each, inſtantly, excites its ſecondary atmoſphere which conſtantly attends it, and, together, they uniformly expand over *all* conducting ſurfaces near them, unleſs peculiarly attracted to one part by the contrary powers:—but, when the two powers are excited by the *animating* principle, the caſe is widely different, as is peculiarly evident in volition; for, when the intellectual

powers tranſmit excitement, by a nerve, to any particular muſcle, that excitement is communicated to both the æthereal and phlogiſtic powers, and proceeds directly from the brain to the *muſcle* whoſe action is determined upon; conſequently, when excitement is communicated by the intellectual powers, that excitement is *confined* to the *very fibres* of the *nerves* which ſupply the *muſcle* to be moved; and the two powers which diſtinctly receive that excitement, neither communicate it to contiguous nervous fibres, nor aſſume the atmoſpheric ſtate of excitement, till they *flow* from the extremities of their reſpective nervous fibrillæ, to the *material* particles in muſcular arrangement, in which they terminate; then, and not till then, they become ſubject to the common law; each aſſumes its primary ſtate of arrangement, and each excites its ſecondary atmoſphere, and reſembles, in all its properties, the ſimilar powers in the electric ſtates of excitement.

8. Intellectual excitement, then, ſeems to be

propagated by the power of *animation* refident in every nerve; and that animating power only excites the æthereal and phlogiftic powers fubject to its influence, to become atmofpheric, when it communicates them to their refpective material particles, in which the animated nervous fibrillæ terminate; each power paffing by its refpective nervous fibrillæ to its refpective material particles in mufcular arrangement.

9. If, then, the vital or animating excitement be communicated to the two powers of the common nerve, thofe powers being mutually excited and feparated, will flow from their refpective nervous fibrillæ, to the material particles in mufcular arrangement, in which they diftinctly terminate, and around which they will arrange themfelves, fo as to form powerfully excited atmofpheres, but of *fmall* extent.

It is poffible that thefe *powers, alone,* may produce mufcular contraction, by flowing in fuch quantities as to come within each other's

influence, when ſurrounding their reſpective material particles; but I by no means think it probable; becauſe, if they were communicated by the nerves in ſuch proportions as to attract each other, and their reſpective material particles into contact, why is the preſence of the *blood*, properly ſupplied with pure air and phlogiſtic aliment, ſo eſſentially neceſſary to muſcular action?—And, again, why ſhould nature diſpenſe with a general law, in this caſe, which ſhe invariably obſerves in producing ſimilar effects, by the ſame powers, in other ſtates of excitement?—For inſtance, when two diſtant particles of matter acquire, the one a phlogiſtic, the other an æthereal atmoſphere in an electric ſtate, thoſe atmoſpheres, invariably, attract around them ſecondary atmoſpheres of wide extent; thoſe external atmoſpheres are evidently different from their primary exciting atmoſpheres; they may attract each other, and be ſeparated again, unaltered, and unaffected by each other; but, the two contrary, primary atmoſpheres inſtantly deſtroy each other's arrangement, and electric properties, by coming

into contact. I, therefore, conclude, that the two powers, excited to flow from the nerves, to the material particles in muſcular arrangement, form ſmall excited atmoſpheres, which *do not* extend to each other.

10. The æthereal and phlogiſtic powers, then, thus excited around their reſpective material particles, and not being within each other's influence, will, according to the 2d general law, immediately excite the *two powers* exiſting in the *blood*, there preſent; the æthereal power excited around the 1ſt, 3d, 5th, &c. material particles, will excite ſecondary atmoſpheres of phlogiſton, while the phlogiſtic power excited around the 2d, 4th, 6th, &c. particles, will excite the æthereal power of the blood, to form ſecondary atmoſpheres around them.

11. Theſe ſecondary or external atmoſpheres being formed of the contrary powers in ſimilar ſtates of excitement, will, then, attract each other, as extending within each other's influ-

ence; by that attraction, they will draw their respective primary exciting powers into contact, and with them the material particles they respectively surround, till those primary atmospheres, by coming in contact, combine, and quitting their connexion with the material particles, lose their nervous excitement, and constitute fire; in which state they will pass into the blood of the muscle: by the combination of the primary atmospheres, the external atmospheres will also become disengaged, and combining in an excited state, will *not* return to their former combinations in the blood; consequently, the acid and antacid principles they were chemically combined with, will be left combined together, in a saline state, in the blood; and the necessity for fresh supplies of air and food to replace those principles, thus discomposed, must be proportionate to the degree of muscular action.

When the *material particles* are drawn so near to each other as to enable the primary atmospheres to come in contact, they must be

greatly approximated; the connecting, simple filaments, necessarily must become *curved*, or *bended aside*; the muscular fibre must become greatly *contracted* in its length, and the solid parts to which its extremities are connected, must, therefore, be brought *nearer* to each other, if the fibre were so connected; or, the length and circumference of the vessel must be *diminished*, in whose composition the fibre forms a part.

From what has been advanced, then, I draw the following general conclusions:

1st. That the cerebrum and cerebellum separate the æthereal and phlogistic powers from the blood.

2d. That the cerebrum separates one power, the cerebellum the other.

3d. That the medulla oblongata, the medulla spinalis, and every nerve proceeding from

them, are formed by the cerebrum and cerebellum.

4th. That every nerve, therefore, confifts of diftinct fibres from both the cerebrum and cerebellum.

5th. That every nerve contains both the æthereal and phlogiftic powers; each power being connected with its diftinct fibres: the fibres connected with the cerebrum conveying one power; thofe connected with the cerebellum the other.

6th. That thefe powers in the nerves are put in motion by the influence of the vital or animating powers, inherent in the brain and nerves.

7th. That the powers in the nerves thus put in motion, diftinctly flow by their refpective fibrillæ, to the material particles in mufcular arrangement, diftant from each other, but connected by fimple filaments.

8th. That the particles receiving the æthereal power of the nervous fibrillæ, alternate with thoſe connected with the phlogiſtic nervous fibrillæ.

9th. That theſe powers thus excited form atmoſpheres of ſmall extent around their reſpective material particles.

10th. That the excited atmoſpheres, thus communicated from the nerves to the material particles of the muſcular fibres, excite ſecondary and extenſive atmoſpheres around them, which they acquire from the æthereal and phlogiſtic powers in the blood there preſent.

11th. That the external atmoſphere, thus formed around each material particle, is ſufficiently extenſive to be within the influence or extent of the next adjoining atmoſphere.

12th. That two external or ſecondary atmoſpheres thus in contact, will attract each other;

becaufe the contrary powers forming thofe atmofpheres alternate with each other.

13th. That by that attraction the primary atmofpheres, which were immediately communicated from the nerves to their refpective material particles, will be brought together, and with them the material particles themfelves.

14th. That by this approximation of the material particles, the mufcular fibre which they form will be fhortened.

15th. That the æthereal and phlogiftic powers communicated to thofe particles by their refpective nervous fibrillæ, being thus brought into contact, will combine, and form fire; which, paffing into the blood, conftitutes animal heat.

16th. That the æthereal and phlogiftic powers of the blood which were excited to form the fecondary atmofpheres, will combine alfo, and the acid and alkaline principles from which

they were ſeparated, will form a neutral ſaline compound; which will remain commixed with the blood till ſeparated by the glands, and expelled.

17th. And that the blood muſt require ſupplies of the æthereal acid and of the phlogiſticated antacid principles, in proportion to the expenditure of thoſe powers and principles by muſcular action.

Thus, then, I explain muſcular contraction of every kind; that is, the contraction of every muſcular fibre I ſuppoſe to be effected by the *two powers* conveyed by the nerves, *attracting* the component *particles* of *muſcular fibres* nearer to each other, in the manner, or upon the principles, or according to the general laws which I have explained (ſect. 6th.) But, muſcular fibres are very different from each other in one reſpect; which is, the mode of their being excited to action. Some muſcular actions being excitable by the will; while

others act independently of it, and can neither be reſtrained, nor accelerated in their actions, directly, by any determination or effort of the mind.

Still, however, in all caſes, the ſimple muſcular fibre, or the ſimple material particles in muſcular arrangement are *paſſive*; conſequently, the reaſons why certain muſcles are ſubſervient to the will, and others are not, muſt be ſought for in the different ſtates or conditions of the *nerves*, by whoſe powers the muſcular fibres are contracted.

As the muſcles ſubſervient to the will, and the nerves connecting them with the brain, ſeem to be the ſimpleſt in their conſtructure, I ſhall, firſt of all, direct my attention to them, under the general title of *voluntary muſcles*, or muſcles of volition; and, then, I ſhall conſider the other claſs, or the *involuntary muſcles*; by which I ſimply mean all the muſcles, or muſcular fibres, whoſe actions are not under

the direct influence of the will. Voluntary and involuntary I apply to the two classes, as terms of conveniency, without contending for their strict propriety.

SECTION VIII.

On the voluntary muſcles, and the nerves by which they are connected with the brain.

1. THE voluntary muſcles are chiefly thoſe of the trunk of the body, of the legs and arms, and of the face.

2. Each voluntary muſcle requires the preſence of the blood with its proper principles, and the powers of the nerves, to excite it, or rather to cauſe it to contract; conſequently, every voluntary muſcle requires a *free* intercourſe with both the brain and the heart, to enable it to diſcharge its functions; for, if the nerve which connects it with the brain be cut, it inſtantly ceaſes to contract, in obedience to the will; and if the arteries which ſupply it

with blood, be cut, its power of contracting is instantly weakened.

3. If the nerve be cut, and that portion below the section be irritated, irregular contractions of the muscle will be excited; because the nerve still retains its usual proportion of the æthereal and phlogistic powers, and also the property of secreting those powers from the blood:—and if the arteries be cut, which supply it with blood, it still will be capable of contracting in some degree, when it receives the nervous powers, because it still retains a portion of blood, in the numerous vessels distributed to it; and simply cutting its proper artery, in general, is not sufficient to deprive it of blood, on account of the anastomoses of the different blood vessels of neighbouring parts with each other.

4. When volition is excited in the brain, that excitement is transmitted along the nerve to the muscle, whose action is determined upon: that voluntary excitement communicated from the

brain to the common nerve, does not, however, excite the æthereal and phlogiſtic powers to become atmoſpheric *in the nerve*; becauſe, in that caſe, thoſe powers could not paſs along the ſimple nervous fibres to which they properly belong, without attracting each other, as being in contact; nor without exciting the powers in the numerous nervous fibres in the ſame bundle, which branch off from the common trunk of the nerve to different muſcles.

5. The excitement of volition, then, when tranſmitted to the voluntary nerve, is ſimply the excitement of *progreſſion*; that is, the æthereal and phlogiſtic powers, appertaining to the correſpondent nervous fibrillæ, proceeding together to any particular muſcle, are, ſimply, excited to move towards the extremities of their reſpective fibrillæ; when there, they will flow to the material particles in muſcular arrangement, in which thoſe nervous fibrillæ reſpectively terminate:—the two powers thus excited to flow, will ſurround their reſpective material particles in an excited ſtate; each power will excite its

contrary power which it meets with in the arterial blood, to form an external atmofphere around it; and thofe external atmofpheres will *attract* each other, and alfo their refpective powers which were excited by, and communicated from, the nerves; and with them, the material particles in mufcular arrangement; by which, the contraction of the mufcular fibres will be effected, as already explained, fect. vii.

6. It is evident, then, that the nerves of volition arife from the brain, and are immediately expofed to the influence of the intellectual powers: that thofe powers determining upon the contraction of a mufcle, tranfmit an excitement to the correfpondent nervous fibrillæ, which convey the æthereal and phlogiftic powers to *that* mufcle: that that excitement is fimply the excitement of progreffion, by which the two powers are made to flow towards their refpective extremities: that the æthereal and phlogiftic powers thus fimply flowing along their refpective fibres, are communicated to their refpective material particles in mufcular arrangement: that they

then excite ſecondary atmoſpheres which they acquire from the powers in the blood in the muſcle, by which the material particles are attracted towards each other, and the muſcle is ſhortened; and that the nerve forms a free and uninterrupted intercourſe between the brain and the muſcle.

SECTION IX.

On involuntary muſcles, or the actions of the heart and vaſcular ſyſtem; with the peculiar ſtructure of their nerves, and the manner in which they are excited.

1. THE involuntary muſcles are chiefly the heart, and vaſcular extremities. By vaſcular extremities I mean the extremities of the arteries and veins in every part of the body, whether it be the brain, the lungs, the muſcles themſelves voluntary or involuntary, the liver, ſtomach, inteſtines, or, in ſhort, any part into whoſe compoſition the arteries and veins enter; for that theſe remote ramifications have a peculiar muſcular action of their own, by which they propel the blood they contain, is too evident, too neceſſary to admit of a doubt; conſequently, theſe vaſcular extremities muſt be interwoven

with mufcular fibres, which form a confiderable part of that clafs which I call involuntary mufcular fibres, as acting independently of the will.

2. The action of an involuntary mufcle, is, in effect, exactly the fame as that of a voluntary mufcle: it is merely a contraction; that contraction is fimply an approximation of its conftituent particles; that approximation is the effect of attraction drawing thofe particles towards each other; that, like every other attraction, is the effect of the æthereal and phlogiftic powers in excitement, combining with each other; and thofe æthereal and phlogiftic powers muft be conveyed to the mufcle by the nerves, as when they produce voluntary action by being communicated to the voluntary mufcles; and the neceffity of the blood, being prefent to affift in the operation, is too evident to need infifting on.

3. That the *nerves* communicate the *powers* which caufe the involuntary mufcles to contract, is evident from analogy with the voluntary mufcles; it is inconteftably proved, alfo, by

this confideration, that if the communication between the brain and the involuntary muf-cles be deftroyed, by cutting the connecting nerves, their actions ceafe; not indeed im-mediately, becaufe the nerves, during life, at all times, contain a confiderable portion of the æthereal and phlogiftic powers, and have, like-wife, moft probably, the power of fecreting it from the blood; confequently, if the communi-cation with the brain be deftroyed, ftill the nerves of the involuntary mufcles will be capable of being excited, fo long as the powers they contain are unexhaufted.

4. That the prefence of the *blood* duly fup-plied with its æthereal and phlogiftic powers, is alfo effentially neceffary to the action of involun-tary mufcles, cannot be denied; becaufe their actions are immediately weakened by the lofs of blood in a confiderable quantity; by the blood being deftitute of pure *æthereal* air; or, by its being exhaufted of the *phlogifticated* principle de-rived from proper aliment; confequently, not only the blood, but alfo the æthereal and phlo-

giftic powers, with their refpective material principles, are neceffary to the action of the involuntary mufcles. The heart, indeed, may contract, when its auricles and ventricles are emptied of blood, becaufe, though thofe cavities contain no blood, ftill, the arteries and nerves every where interwoven with the mufcular fibres, forming the very *fubftance* of the heart itfelf, ftill retain their blood; and till that blood, and the nerves accompanying it, to every mufcular fibre of the heart, be exhaufted of their powers, the heart may be excited to contract; unlefs the vital principle itfelf, which excites thofe powers to motion, be deftroyed.

5. I affume it then as a fact, that the involuntary mufcular fibres are made to contract, by the æthereal and phlogiftic powers communicated by the nerves, exciting the powers in the blood; by the attraction of which contrary powers, the component particles of the involuntary mufcular fibres are drawn together, and the fibres fhortened; in the fame manner as the contraction of the voluntary mufcular fibres is ef-

fected; and, therefore, I shall not again repeat the particulars of the process.

6. It is now proper to consider, why these involuntary muscles are *not* subject to the will, as the voluntary muscles are, since their actions are both produced, in the same manner, by the conjoint influence of the powers of the nerves and in the blood. That reason must be sought for in the conditions of the *nerves* themselves; and a slight attention to the respective nerves, supplying the two classes of muscles, will be sufficient to point out that reason.

7. It has already been observed (sect. viii. 2.) that the intercourse between the brain and the voluntary muscle must be uninterrupted; and if we examine those nerves of volition, we find that they are free, and uninterrupted in their course; but, as the influence of the brain cannot be directly transmitted to the *involuntary* muscles, it must follow, that the connecting nerves must be *interrupted* in their course between the brain and those muscles; and anatomy teaches us that

every nerve, paſſing from the brain to thoſe involuntary muſcles, *does* paſs into one or more *ganglia*; and from thoſe ganglia they proceed to the involuntary muſcles; but, not unfrequently, that progreſs is again interrupted by moſt intricate plexuſes. The ganglia are invariably found to intercept the nerves of the involuntary muſcles: they are never found in any part of the courſe of the nerves of volition; therefore, it is a reaſonable deduction, that the ganglia do interrupt the direct intercourſe between the brain and the muſcular fibres, whoſe actions are involuntary.

8. The *intercoſtal* or *great ſympathetic nerves* are the grand ſource, from whence the nerves ſupplying the heart, and the vaſcular extremities of the ſtomach, inteſtines, liver, and abdominal viſcera in general, are chiefly ſupplied; the actions of all thoſe parts are involuntary, and the nerves by which they are ſupplied, are ſent off from the ganglia of the intercoſtals. In fact, the intercoſtal nerves ariſe, commonly, from the fifth and ſixth pair of the medulla oblongata,

and from *all* the *ſpinal nerves,* in ſucceſſion, which ſend off branches which paſs into the ganglia of the intercoſtals, and from thence to the muſcular fibres of the heart, and vaſcular extremities of the parts mentioned.

9. The æthereal and phlogiſtic powers of the brain, then, flow along their reſpective nerves to the ganglia of the intercoſtal nerves; and from thoſe ganglia they flow along the nerves, proceeding from them to the heart and vaſcular extremities.

The ganglia, then, do not intercept the flow of the two powers from the brain to the voluntary muſcles; but they receive them from the brain by the nerves intervening, and then tranſmit them by nerves proceeding from them to the involuntary muſcles; they, therefore, prevent the brain from tranſmitting the two powers, *directly*, by an uninterrupted courſe to any involuntary muſcle; and they prevent impreſſions made upon the extremities of thoſe nerves, from

being, *immediately*, conveyed to, or perceived by the brain.

10. The intercoſtal nerves, then, are, as it were, two chains of ganglia, from which the muſcles are ſupplied, which perform the conſtant and involuntary actions requiſite for the circulation of the blood through the heart, and the blood veſſels in the ſtomach, inteſtines, liver, and, in ſhort, all the abdominal viſcera in particular. But, there are other involuntary actions of the vaſcular extremities, ſtill more diſtant from the heart, or centre of the circulating powers by which the blood is moved; theſe are the arterial and venous extremities forming ſo large a portion of all the *voluntary* muſcles *themſelves*, of all the extremities: the more diſtant thoſe vaſcular extremities are from the heart, the more neceſſary is the action of the muſcular fibres, interwoven *with* thoſe vaſcular extremities.

11. The vaſcular extremities, therefore, of the voluntary muſcles, muſt have an *involuntary*

action, by which the blood is propelled through them, at all times, whether the muſcle be in voluntary action or not; and as the circulation of the blood through thoſe diſtant muſcles muſt be chiefly effected by the involuntary actions of the ſanguiferous veſſels themſelves, it is evident, that a conſiderable portion of nervous powers, muſt be conſtantly neceſſary, to keep up thoſe actions; and, as thoſe muſcular fibres which perform thoſe actions are involuntary, the nerves, by which thoſe muſcular fibres are ſupplied with power, muſt be intercepted by *ganglia*, in their courſe from the brain to thoſe vaſcular extremities.

12. If we attend to the anatomy of thoſe parts, and of the nervous ſyſtem, we inſtantly perceive that the voluntary muſcles are ſupplied with nerves paſſing through ganglia.

All the ſpinal nerves, which are the nerves diſtributed to the voluntary muſcles, are formed of bundles of nervous fibrillæ, ariſing from both the anterior and poſterior parts of the

medulla ſpinalis. The anterior bundles combine with the poſterior, and paſs free from interruption, from the medulla ſpinalis to the voluntary muſcles; conſequently, thoſe nerves form a free intercourſe between the brain and the voluntary muſcles: but, the *poſterior* faſciculi of nerves, ariſing from the medulla ſpinalis, *paſs* into *ganglia*, before they unite with the anterior faſciculi and proceed in one common bundle to the muſcles of volition.

13. The ſpinal nerves, diſtributed to the voluntary muſcles, then, are formed of bundles of nervous threads ariſing from the anterior part of the medulla ſpinalis, which paſs freely and without interruption to the voluntary muſcles; and of bundles of nervous fibrillæ, ariſing from the *poſterior* part of the medulla ſpinalis, which *paſs* into *ganglia*; and from thoſe ganglia nervous fibres proceed, and coaleſce with the anterior nerves, to form the common nervous trunks which are diſtributed to the voluntary muſcles. The anterior branches of the ſpinal nerves being free from interruption, convey the

powers, excited by volition, to the muſcles, which are obedient to the will; and the poſterior branches having paſſed through ganglia, are diſtributed to the muſcular fibres of the blood veſſels in the voluntary muſcles to keep up their involuntary actions, without being under the influence of the will.

14. It appears very evident, then, that every nerve which paſſes in an *uninterrupted* courſe from the brain, or the medulla oblongata, or ſpinalis, which are formed by the cerebrum and cerebellum, to a muſcle, is a nerve of volition; and that every nerve proceeding from the brain, and paſſing into a *ganglion,* before it is diſtributed to a muſcle, is *not* under the power of the will, when it paſſes from the ganglion to the muſcle to which it is diſtributed.

15. A nerve of volition, then, conveys the powers excited to flow along it by mental volition, in a *direct* courſe to the material particles in muſcular arrangement; thoſe powers flowing along their reſpective nervous fibrillæ, to their

correſpondent muſcular particles, ſurround them in a ſtate of excitement; each power excites its ſecondary atmoſphere, which is formed of the powers in the blood, and thoſe atmoſpheres of the contrary powers, by attracting each other, produce the contraction of the muſcular fibre, as before (ſect. vii.) amply explained.

16. But, as the nerves which paſs to the heart, and the extremities of the blood veſſels, in every part of the ſyſtem, are interrupted by paſſing through ganglia, the powers excited to flow from the brain to thoſe nerves, cannot *directly proceed* further than theſe ganglia; from whence they flow by a regular *diffuſion* along the nerves ariſing from thoſe ganglia, to be diſtributed to the heart and vaſcular extremities. The flow of the excited powers to the ganglia, is an excitement ſufficient to cauſe them to diffuſe themſelves along the nerves extending to the involuntary muſcular fibres: by that flow the powers are accumulated in thoſe nerves; but, the brain *cannot*, on account of the interrupting ganglia, propagate that excitement, which is neceſſary to

discharge the two powers, from the extremities of their respective fibrillæ to the muscular fibres, so as to cause them to contract.

17. The involuntary nerves, then, arising from ganglia, *constantly* receive a flow of the æthereal and phlogistic powers from the cerebrum and cerebellum, by means of the ganglia; but that is merely the flow of simple diffusion, not of excitement; for though the æthereal and phlogistic powers diffuse themselves along their respective nervous fibres, still, the energy of the vital or animating principle is wanting, to give them that excitement upon which their power of flowing in an excited atmospheric state to the muscular fibres, and causing them to contract, depends; consequently, the involuntary nerves require the application of *stimuli* to excite them to propel their powers to the muscular fibres, so as to cause them to contract; at least, the application of stimuli is necessary to excite those nerves to perform their functions with that degree of vigour which is required.

18. That this is in reality the cafe, is abundantly evident; for if the blood be denied the influence of atmofpheric air in the lungs, the heart will *ceafe* to act:—when the heart has ceafed its motions, the application of ftimuli will excite it to *renew* them, if applied within a certain time; and in cafes of fufpended animation the application of pure air to the lungs, will frequently reftore the involuntary actions of the *mufcles* by its ftimulating effects upon the *nerves*.

19. It is by no means improbable, that the powers flowing from the brain to the ganglia, may ftill retain excitement fufficient to produce their flow from the nervous extremities to the involuntary mufcles, fo as to keep up a conftant action, *independent* of any ftimulus; but, at the fame time, it muft be granted, that the application of ftimuli to thofe nerves, *does* excite their action; and, that the conftant application of the natural ftimuli of pure air and proper food, is neceffary to excite thofe involuntary actions to a *due* degree of vigour.

20. It has already been obſerved, (ſect. vii.) that every muſcular fibre, voluntary or involuntary, is made to contract by the æthereal and phlogiſtic powers, flowing in a ſtate of excitement, to their reſpective particles of matter in muſcular arrangement :—we know that certain ſtimuli will excite the heart to contract, even when ſeparated from the body, immediately after its ſpontaneous contractions have ceaſed: we know that the blood, duly ſupplied with its requiſite principles and powers, *does* excite the heart to contract in the living body: we know that the blood does *not* excite the voluntary muſcles to action; and we know that if a nerve of volition be irritated, the voluntary muſcle is put into action; conſequently, the nerves of the voluntary muſcles, are *not* expoſed to the action of ſtimuli, of any kind, in the natural, healthy ſtate, but convey the excitement of volition, directly, from the brain to the muſcular fibres, without being expoſed to the influence of any other exciting cauſe: but, on the contrary, the involuntary nerves *are* expoſed to the influence of the blood, which acts as a *ſtimulus*; and

that ſtimulus excites the nerves to propel their æthereal and phlogiſtic powers, in an excited ſtate, to the muſcular fibres, which cauſes them to contract.

21. If a nerve of volition be irritated in its courſe, the muſcle is thrown into action; therefore the nerves terminate, *directly*, in the muſcular fibres: but if an involuntary nerve be irritated in its courſe, the involuntary muſcle does not contract; which proves that the nerve does *not*, directly, terminate in muſcular fibres; but, that its fibres are *again interrupted* when they reach the muſcle, and then are diſtributed to the muſcular fibres.

22. Whatever be the ſtate which the nerves aſſume, when they reach the involuntary muſcles, it is evident that the excitement of the trunk of the nerves ſtops there, when irritated; and it is evident, that the nerves, thus diſtributed upon the ſurfaces of the blood veſſels and heart, are excitable by ſtimuli; and that from thence the excitement is propagated to the extremities of

the nervous fibrillæ, which immediately terminate in the material particles in mufcular arrangement ; fo that whenever this *nervous expanfion* on the furfaces of the heart and blood veffels is excited, by proper *ftimuli,* that excitement is propagated by the nervous fibrillæ which proceed from this nervous expanfion to the mufcular fibres themfelves.

23. I think it then ftrictly allowable to draw the following conclufions :

1ft. That the nerves of volition proceed from the brain, and pafs in an uninterrupted courfe to the material particles in mufcular arrangement, without being expofed to any intervening influence.

2d. That thofe nerves are connected with both the cerebrum and cerebellum, and convey the æthereal power from the one, and the phlogiftic power from the other, by diftinct, but correfpondent fibres, to their refpective material par-

ticles, alternating with each other, in mufcular arrangement.

3d. That the involuntary nerves pafs through ganglia, before they are diftributed to the muf-cles of involuntary action; which ganglia prevent the direct intercourfe between the brain and the mufcles, and render them incapable of immediately influencing each other.

4th. That involuntary nerves, like the voluntary, are connected at their origins, *previous* to their entering the ganglia, with both the cerebrum and cerebellum, and convey the æthereal and phlogiftic powers by diftinct, but correfpondent fibres.

5th. That the involuntary nerves, proceeding *from* the ganglia, are expanded upon the *furfaces* of the heart, and vafcular extremities, particularly their *internal* furfaces, and are intimately *interwoven* with each other; in which ftate, the nerves with their æthereal and phlogiftic powers are expofed to the influence of the blood, or

ſuch ſtimuli as are conveyed by the veſſels, within which they are thus expanded.

6th. That from that nervous expanſion, fibrillæ ariſe, which are diſtributed to the material particles in muſcular arrangement.

7th. That when the æthereal and phlogiſtic powers of the nerves, thus mutually expanded on the ſurfaces of the heart and blood veſſels, are excited, by the action of the blood, or other ſtimuli, that excitement cauſes them to flow by their reſpective fibrillæ, to the material particles in muſcular arrangement, in which they terminate.

8th. That thoſe particles being alternately arranged, the powers thus excited to flow around them, will excite the contrary powers in the blood; by the attraction of which the muſcular fibres will be made to contract, as hath already been particularly explained.

SECTION IX.

On the additional influx of power to the heart and vafcular extremities, or to the involuntary nerves, in confequence of the exertion of the voluntary mufcles.

1. WHENEVER the voluntary mufcles are excited to action, the contractions of the heart and involuntary mufcular fibres are, proportionately, increafed in ftrength and frequency.

2. This increafed action of the involuntary mufcles, is *not* the effect of *motion*; becaufe, if the voluntary mufcles be violently excited to *rigid inflexibility*, ftill, the actions of the heart, &c. will be inftantly *increafed*; confequently, the nerves which impart the attracting powers to the involuntary mufcles, muft receive an additional

flow of thoſe powers from the brain, at the ſame time, that the powers are excited to flow from the brain to the voluntary muſcles.

3. It muſt then follow, that the voluntary nerves have a direct *communication* with the involuntary nerves; ſo that the æthereal and phlogiſtic powers cannot flow along the former without a partial communication to the latter.

4. If we attend to the actual ſtate of the nerves in the human body, we ſhall ſoon be convinced that ſuch is the caſe; for the voluntary muſcles are chiefly ſupplied with their nerves from the medulla ſpinalis; and all the ſpinal nerves ſend off branches which paſs to the ganglia of the intercoſtal nerves.

5. The branches of the ſpinal nerves, then, which are ſent to the ganglia of the intercoſtals, have a direct communication with the voluntary nerves; ſo that no powers can be tranſmitted to the voluntary muſcles, without a portion of thoſe powers paſſing to the intercoſtal nerves, and

from the ganglia of thoſe nerves to the heart, and vaſcular extremities; conſequently, thoſe nerves when expanded upon the ſurfaces of the heart and ſanguiferous veſſels, by this acceſſion of powers, are more capable of acting with vigour, and are more readily and frequently excited by the common ſtimulus of the blood; becauſe this accumulation of the two powers, more quickly reſtores the loſs of thoſe powers when diſcharged to the muſcular fibres, than when the nerves are leſs copiouſly ſupplied with them.

6. For the ſame reaſons we may conclude, that the poſterior fibres ariſing from the ſpinal marrow, and paſſing through ganglia, before they coaleſce with the uninterrupted anterior faſciculi of nerves, to be diſtributed, together, to the voluntary muſcles, are, alſo, ſo connected with the anterior, voluntary portions of thoſe nerves, as to receive a flow of power, in augmentation, whenever the voluntary portions of thoſe nerves are excited; ſo that the vaſcular actions of thoſe muſcles may be increaſed, for

the purpofe of accelerating the flow of blood through them when in action : for, as the prefence of blood is neceffary to enable the voluntary mufcles to act, the more thofe mufcles are exerted, the more blood is neceffary to fupport thofe exertions ; and the voluntary nerves thus communicating a part of the powers excited to flow along them to the involuntary nerves, correfponding to them, is wifely adapted to anfwer that neceffary end.

7. *All* the nerves of volition, then, *do communicate* by collateral branches with the *intercoftal nerves*, which fupply the heart and vafcular extremities of the abdominal vifcera; and every particular nerve, fupplying any *voluntary* mufcle, communicates with the involuntary nerve accompanying it to be diftributed to the extremities of the *blood veffels* of that mufcle ; confequently, whatever quantity of the æthereal and phlogiftic powers, is tranfmitted from the brain to the voluntary mufcles, a proportionate flow of thofe powers muft pafs to the ganglia of the intercoftal nerves, and from thence to the heart

and vascular extremities of the abdominal viscera; and, at the same time, whatever voluntary muscle is excited, a proportionate flow of the two powers must pass, in addition, to the involuntary nerves accompanying the voluntary nerve excited, that the involuntary actions of the blood vessels in the muscle excited to act, may correspond to the voluntary exertion of that muscle, that the muscular fibres may be supplied with blood, in proportion to the want of it to enable the muscular fibres to contract.

8. Every voluntary nerve, then, must have its correspondent involuntary nerve, that the flow of powers from the brain may be, at all times, proportionate, to both; so that the involuntary actions by which the blood is circulated may be proportionate to the voluntary actions requiring that blood to assist in their contractions:—therefore, every voluntary nerve must intimately communicate with its correspondent involuntary nerve, either in the brain, or in some part of its course. The voluntary nerves convey their powers *directly* from the brain to the voluntary

muſcle; but the correſpondent involuntary nerves convey their powers to the interrupting *ganglia*, from which the powers *diffuſe* themſelves to all the nerves ariſing from thoſe ganglia: ſo that the powers flowing to the ganglia of the intercoſtal nerves, from whatever voluntary nerve they are derived, diffuſe themſelves to all the parts to which thoſe involuntary nerves extend, below the ganglia; but any of the involuntary ſpinal nerves accompanying the voluntary nerves in their courſe to the voluntary muſcles, of neceſſity, convey their additional excitement to the vaſcular extremities of *that muſcle only*, whoſe correſpondent voluntary nerve is excited.

9. It hath already been obſerved (ſect. vii.) that the nervous fibres, when excited by volition, do not tranſmit their reſpective powers in an atmoſpheric ſtate; but that the *intellectual excitement* is ſimply a *progreſſive motion* of the *powers* along the nervous fibres; which powers only become *atmoſpheric*, when they paſs from the *nervous extremities* to the *material particles* in muſcular arrangement; becauſe, any particular

muſcle may be thrown into action by the will, without other muſcles being affected, although they are ſupplied from the ſame, common, nervous trunk as the former.

10. It is evident, then, that every voluntary muſcle has an immediate connexion with the brain by *diſtinct* nervous fibres, peculiarly appropriated to *that* muſcle alone; and, that nervous fibres, diſtributed to different muſcles, or diſtant muſcular fibres, when excited by the flow of powers from the brain, *do not* communicate their excitement, neceſſarily, to the nervous fibres in the ſame bundle, by contiguity.

11. It is evident, however, that nerves, in ſome caſes, *do* communicate with each other, in ſuch manner that the one *cannot* be excited without the other; for example, the nerves which terminate in the muſcles of the eyes, are diſtinct nerves, and diſtributed to parts diſtant from each other; yet, whenever, by volition, one eye is raiſed upwards, the other is raiſed alſo; which proves that the nerve which ſupplies the elevator which raiſes one eye, is connected with the

nerve which excites the mufcles to elevate the other; and that one naturally cannot receive excitement from the brain, without the other. That it is not owing to the nerves arifing in pairs, or being fimilarly excited, as paffing to correfponding mufcles, is very evident, from this, that the mufcles which are excited to move the pupil of one eye *towards* the nofe, invariably act with the mufcles which move the pupil of the other eye, *from* the nofe; confequently, in this cafe, the nerve which fupplies the adductor mufcle of one eye, communicates fo intimately with the nerve fupplying the abductor of the other, that whenever the brain by volition excites a flow of the æthereal and phlogiftic powers to the one, an equal proportion at the fame time flows to the other.

It is not in the eyes alone, that fuch nervous connexions take place; for even the nerves which fupply the voluntary mufcles of the diftant extremities, may be fo connected at their origin as to act invariably with each other. In moft people the nerves which fupply the mufcles

of the fingers of the right hand, have no particular connexion with thofe of the left; and the volition which excites the right hand mufcles to act, flows to thofe mufcles without any fuch flow of powers, neceffarily paffing to the fimilar nervous fibres of the left; but there are inftances of people who from their infancy never could open or fhut one hand, without an involuntary action of the mufcles of the other hand to open or fhut it alfo; neither can they move any finger or joint, of one hand, without the fimilar finger or joint of the other being moved in the fame manner: it is evident, then, that the nerves diftributed to one part may fo communicate with nerves fent to another, that the excitement of the brain imparted to one is directly communicated to the other.

12. Whether the voluntary nerves communicate with the involuntary nerves in the brain, or betwixt the brain and ganglia, or fend branches to the ganglia themfelves, is, in general, the fame in effect; for if an additional flow of powers to the ganglia is tranfmitted by means

of the excitement of the voluntary nerves, that is what is neceſſary; as the powers will then diffuſe themſelves to every part, to which the involuntary nerves are diſtributed, from the ganglia receiving the powers derived from the excited nerves of volition.

From the preceding conſiderations the following general concluſions may be drawn:

1ſt. That all the voluntary nerves ſend off branches to the ganglia of the intercoſtal nerves.

2d. That whenever by the excitement of volition, the æthereal and phlogiſtic powers are tranſmitted from the brain, by the voluntary nerves, to produce the action of the voluntary muſcles, a *proportionate* flow of thoſe powers is communicated by thoſe branches to the *ganglia* of the *intercoſtal nerves*: conſequently,

3d. That the involuntary muſcles, to which the intercoſtal nerves are diſtributed, muſt receive a flow of the æthereal and phlogiſtic powers

from the voluntary nerves, whenever they are excited, and in proportion to the voluntary actions they produce;—ſo that,

4th. The actions of the heart, &c. are, at all times, increaſed by voluntary exertions, and in proportion to the degrees of thoſe exertions, or actions.

5th. That involuntary, or poſterior faſciculi of the ſpinal nerves, are ſo intimately connected with the anterior or voluntary fibres of thoſe nerves, that the powers excited by volition to flow along the voluntary nerves, are partly communicated to the involuntary nerves accompanying them;—conſequently,

6th. That the involuntary actions of the ſanguiferous veſſels of a voluntary muſcle, are always increaſed, by the powers exciting that voluntary muſcle to act, and in proportion to the degree of action: therefore,

7th. That the heart and involuntary muſcular

fibres of the blood veſſels, thus receiving an additional flow of the æthereal and phlogiſtic powers, in proportion to the flow of thoſe powers to the voluntary muſcles, muſt be more powerfully and repeatedly *excited* to contract, by the *blood* to whoſe influence their nerves are expoſed ; and, conſequently,

8th. That the blood, by the increaſed actions of the heart and blood veſſels, muſt be circulated through the ſyſtem with a velocity, increaſed in proportion to the degree of voluntary action ; —and,

9th. That the rapidity of the circulation of the blood through a voluntary muſcle in action, muſt ſtill exceed the general velocity of circulation ; becauſe, the voluntary nerves of that muſcle, beſides the general communication to the intercoſtal nerves, have a particular connexion with the involuntary nerves accompanying them to the muſcle itſelf ; and, therefore,

10th. That the quantity of blood circulated

through the ſyſtem, or to any voluntary muſcle, is naturally, proportionate to the quantity that is required there, to ſupport the actions of the muſcular fibres; to the production of which muſcular actions its preſence is ſo eſſentially neceſſary.

SECTION X.

A general view of the nervous and ſanguiferous ſyſtems, particularly with reſpect to their mutual dependance upon, and co-operation with, each other.

1. FROM what hath been already advanced, it is evident that the brain derives all its powers from the blood, tranſmitted to it from the heart; and it is equally certain that the contracting power of the heart is derived from the nerves, which convey it from the brain; ſo that the functions of the brain and nerves, depend upon the ſupply of blood from the heart and arteries; and the actions of the heart and arteries, in their turn, depend upon ſupplies of the two powers from the brain and nerves.

2. When the heart propels its blood to the

brain, that very blood excites the brain to exercise its functions :—that blood conveys the æthereal and phlogistic powers, which are separated by the cerebrum and cerebellum; and every new accession of blood, excites the brain to diffuse its secreted powers, by their respective nervous fibres to every part of the body.

3. So long as the brain keeps receiving due supplies of blood, of proper qualities, so long it keeps separating from that blood the æthereal and phlogistic powers; which as constantly diffuse themselves along the nerves to every part.

4. The powers thus constantly separated by the brain, and *diffusing* themselves along the nerves, are *not* in an excited state ;—they flow by simple diffusion ; without the vital or animating powers of the brain, or nerves, being excited; and, consequently, without the power of flowing from the nervous extremities, or of assuming an atmospheric state. It is the *simple flow* of fluids tending to an *equilibrium*; for, as the

brain is conſtantly *receiving* freſh ſupplies of powers from the blood, theſe powers muſt *diffuſe* themſelves into all the nerves, but particularly *thoſe* which are the moſt *exhauſted,* to prevent an undue accumulation in the brain.

5. The æthereal and phlogiſtic powers, then, *conſtantly flow* to all the nerves connected with the brain, whether voluntary, or involuntary; but that is the flow of ſimple *diffuſion,* without the vital or animating excitement; and the nerves thus become ſupplied with their reſpective powers which conſtitute their *excitability*:—for, if the excitement of *volition* be communicated from the brain to a voluntary nerve, that excitement inſtantly gives progreſſive motion to the powers, which flow from their extremities in an excited ſtate, to the muſcular fibres, and cauſe them to contract; or, if a *ſtimulus* be applied to the vaſcular expanſions of the involuntary nerves, the powers diſtributed to thoſe nerves will be inſtantly excited to flow from the nervous extremities, proceeding from thoſe vaſcu-

lar expanſions of the nerves, to the fibres of the involuntary muſcles, and will cauſe them to contract.

6. So long, therefore, as the brain is ſupplied with *blood* of proper qualities, ſo long will the nerves convey the *æthereal* and *phlogiſtic* powers to the *heart* and *vaſcular extremities*; and ſo long as the blood is ſupplied with atmoſpheric air and proper food, ſo long will the heart contract, by the ſtimulating effects of the blood, thus duly ſupported, acting upon the powers tranſmitted from the brain to the nerves of the heart and blood veſſels: ſo long will all the involuntary muſcular fibres be excited to perform their due actions; and ſo long will the voluntary nerves be ready to execute the volitions of the mind, by having powers wherewith to excite the voluntary muſcles to contract, with the aſſiſtance of the blood duly ſupplied to thoſe muſcles by the actions of the involuntary muſcles.

7. The functions of the brain and nerves,

of the heart and blood veſſels, of the muſcular fibres voluntary and involuntary, and of every organ compoſed of thoſe diſtinct and eſſential parts, in an healthy animal, will be duly performed, ſo long as the *blood* is duly ſupplied with *pure air* and *proper food*, but *no longer*.

8. It is not the pureſt air, the moſt generous food, nor the richeſt cordials, that, *ſingly* applied, can ſupport the functions of the living body: it is not the *acid* principle in its pureſt ſtate, nor the *antacid* principle in its greateſt purity, that can enable the blood to ſupport the functions of the living man; it is the acid principle, rendered *aeriform* by its atmoſpheric arrangement of the *æthereal power*, and the antacid principle, with its *phlogiſtic power* in certain proportions and ſtates of combination, which, *together*, can ſupport the living powers, and they only:—for if the blood be not duly ſupplied with *both* theſe principles and powers, it cannot long excite the powers in the nerves, to produce the involuntary actions, neceſſary for

its tranfmiffion to the brain; and when the exhaufted blood does arrive at the brain, it can no longer fupply thofe powers which the nerves require from the brain, to enable them to produce the contractions of the mufcular fibres; without which, the circulation muft ceafe, and all the functions of life depending upon it.

Since, then, conftant fupplies of pure air and proper food are neceffary to fupport life, the body muft be fo conftituted as to render thofe fupplies defirable; and fuch mufcular exertions as are neceffary to their acquifition and application to the blood, muft be excited in confequence of their *deficiency* in the fyftem.

9. Such in reality is the cafe; the *deficiency* of *pure air* is productive of a *defire* to *breathe* pure air, and excites the mufcles which expand the *thorax*, by which the air rufhes into the lungs, and imparts its influence to the blood: and the *deficiency* of proper *food* produces the *fenfation* of *hunger*, and excites fuch mufcular exertions

as are neceſſary to procure proper aliment, and convey it to the ſtomach.

The next ſubject of inveſtigation, therefore, ſhall be reſpiration.

SECTION XI.

On respiration, or the manner in which the muscles, subservient to the expansion of the thorax, are excited to act, in consequence of a deficiency of pure air in the blood.

1. RESPIRATION is a complex operation, in which many muscles are concerned :—what those muscles are it is not essential to my subject to particularly explain. My particular object, at present, is to show in what manner the *dilation* of the thorax is necessarily produced, for the purpose of supplying the blood with air.—The muscles of inspiration, or those which enlarge the dimensions of the thorax, are then the only muscles under consideration ; and they, indeed, are the muscles chiefly concerned in natural respiration ; for when their actions cease, the parts forming the thorax will

return to their previous ſtates, ſo as to expel part of the air from the lungs, without any muſcular exertion being eſſentially neceſſary.

2. The muſcles, then, whoſe actions are particularly the ſubject under conſideration, are chiefly the diaphragm, and the intercoſtals; when theſe muſcles are excited to contract, the capacity of the thorax is enlarged, and the air ruſhes into the lungs, to diſtend them, ſufficiently, to ſtill fill up the cavity of the thorax, though enlarged:—this I call inſpiration;—theſe I call the muſcles of inſpiration; and, ſometimes for conveniency, the muſcles which expand the lungs, without contending for the propriety of the expreſſion.

3. When theſe muſcles ceaſe to act, the thorax is inſtantly contracted in its dimenſions, by the parts returning to their natural or uſual ſtate; in conſequence of which the expanded lungs will be compreſſed, and a volume of air will be expelled by this compreſſion, equal to what was taken in to expand them, when the thorax was

dilated: this I call expiration, without taking into account thofe mufcles which may, particularly on preffing occafions, affift in the difcharge.

4. The mufcles of infpiration are fubject to the will, at leaft to a certain extent; becaufe their actions may be accelerated, or retarded by volition; but when not controlled by the will, they act involuntarily, and, in general, inconfcioufly.

5. But thefe actions are the fame, and the effects the fame, whether they be involuntarily or by volition; confequently, thefe actions are produced by the fame means in both cafes.

6. We know that a voluntary mufcle is made to act, by the two powers being excited to flow along the nerves to the mufcular fibres: the mufcles of infpiration, then, being fubject to the will, muft be made to act by the powers being excited to flow along the nerves to thofe mufcles:—but as their actions are the fame

whether they be excited by volition, or involuntarily, it muſt follow, that theſe muſcles of inſpiration are, in all caſes, thrown into action by the æthereal and phlogiſtic powers of the nerves, ſupplying theſe muſcles, being excited to flow along their nervous fibres; and not by the ſtimulus of the blood acting on their extremities, as is uſual in other involuntary actions.

7. When the muſcles of inſpiration act, air ruſhes into the lungs, and their action *ceaſes*, if that air be pure; but, if *no air* be admitted to the lungs, or that air be *impure*, their *actions continue*, or are quickly *repeated*; and thoſe actions, or a tendency to act, continues with pain and anxiety, till pure air is admitted, or till the functions of the ſyſtem are impaired.—If, again, pure air *be* admitted, the actions of the muſcles of inſpiration *ceaſe*; till the air, remaining in the lungs, becomes impure, and freſh ſupplies of pure air be wanted.

8. It is evident, then, that it is *not* the pure air which excites the muſcles of inſpiration to

act; becaufe, when it is received into the lungs, their action *ceafes:* but, it is the *want* of pure air which gives rife to the excitement of the nerves, which caufes thofe mufcles to act, as is evident from the violent and quickly repeated efforts to infpire, when pure air is not admitted to the lungs, to remove that caufe which keeps up the excitement of the nerves of thofe mufcles.

9. When the mufcles of infpiration act, then, the powers of the nerves fupplying thofe mufcles are *excited*; when *air* is admitted into the lungs, that *excitement* of thofe nerves *ceafes;* if pure air be *not* admitted, the excitement is *kept up* with anxiety and pain, till the natural functions of the fyftem are impaired.

10. Pure air, then, when admitted into the lungs, *removes* the excitement of the powers of the nerves fupplying the mufcles of refpiration; and, when pure air is *not* admitted into the lungs, the excitement of thefe nerves *increafes:* it is evident, therefore, that the excite-

ment of the nerves ſupplying the muſcles of inſpiration, depends upon the ſtate of the lungs.

11. But, that ſtate of the lungs cannot communicate its influence to the nerves of the muſcles of inſpiration, by means of the blood; becauſe, that communication is inſtantaneous:—conſequently, then, it muſt be the *nerves* diſtributed to the lungs which communicate their influence to the *nerves* of the muſcles of inſpiration; and upon the ſtate of thoſe nerves of the lungs, the excitement of the nerves of the muſcles depends.

12. The muſcles of inſpiration act when the powers are excited to flow along their nerves. If pure air be not admitted to the lungs, that flow of excited powers to the muſcles is increaſed:—by what?—by the influence of the nerves of the lungs:—then, when the nerves of the lungs are *not* ſupplied with pure air, they *increaſe* the excited *flow* of the powers of the nerves belonging to the *muſcles* of inſpiration.

If pure air *be* admitted to the nerves of the lungs, the flow of excited powers to the muſcles of inſpiration *ceaſes:* conſequently, then, the pure air *takes away* from the nerves of the lungs *thoſe powers,* which, when *not* diſcharged from thoſe nerves of the lungs, are *communicated* to the nerves which ſupply the *muſcles of inſpiration,* and cauſe them to contract.

13. The nerves of the lungs, then, conſtantly receive a flow of the æthereal and phlogiſtic powers from the brain; when thoſe powers *accumulate* to a certain degree, they *flow* to the *nerves* which ſupply the *muſcles* of *inſpiration,* and cauſe them to *act*; by their action, the lungs are expanded by pure air; that air *diſcharges* the nerves of the lungs of their powers; and by that diſcharge the collateral *flow* to the nerves of the *inſpiratory muſcles* ceaſes, and they *ceaſe* to act:—but as the flow of the nervous powers to the lungs is conſtant, if pure air be denied, the powers will be accumulated in thoſe nerves to a certain degree, when the reſt will totally paſs to the nerves of

the mufcles of infpiration, and excite them to violent and repeated actions, either till pure air be admitted to difcharge the nerves of the lungs, or till the functions of the nerves are deftroyed by the want of æthereal power in the brain.

14. For what purpofe is this conftant and copious flow of the nervous powers to the lungs, and which are the nerves which convey them? —The nerves which are chiefly diftributed to the lungs are the *par vagum*, with fome branches from the intercoftals, occafionally interwoven. If we cut thefe nerves, then, the effects they are deftined to produce will be difcovered by the want of them.

15. If the par vagum and intercoftals be cut, refpiration inftantly becomes laborious and difficult; in a fhort time, the animal dies, and the lungs are found *loaded with blood*.

16. It appears, then, that the nerves of the lungs are for the purpofe of keeping up the

vaſcular actions there; of ſuch vaſt importance to man! ſince, as much blood paſſes through the lungs in any given time, as through all the arteries in the reſt of the body.—The par vagum, then, is diſtributed to the lungs, and particularly to the pulmonary arteries and veins, to cauſe them to contract and propel the blood from the right to the left ſide of the heart; for when thoſe nerves are cut, the pulmonary veſſels are no longer excited by the blood, ſufficiently, to promote its tranſmiſſion through them.

17. It is obſervable, that the reſpiration becomes laborious, as ſoon as thoſe nerves are cut. Why? Becauſe the *powers* which naturally flowed along the par vagum, and were *diſcharged* in producing the vaſcular actions of the lungs, now *cannot flow* along thoſe nerves, further than the extremities where they were cut; conſequently, as the nerves of the muſcles of inſpiration are connected with them, *thoſe powers* muſt *flow* to the *muſcles* of *inſpiration,* in unuſual proportions, and diſcharge

themſelves there, by producing deep and unnatural actions of thoſe muſcles, till the ſupplies of thoſe powers from the brain fail, and death enſues.

18. The branches of the par vagum, diſtributed to the lungs, then, keep up the actions of the pulmonary veins and arteries; particularly their minute ramifications in the bronchial cells:—but thoſe actions are involuntary; conſequently, thoſe pulmonary branches of the par vagum muſt be *interwoven*, upon the *ſurfaces* of the *pulmonary veins* and *arteries*, ſo as to form a nervous or medullary plexus, like the other involuntary nerves; and thoſe nervous expanſions muſt be ſtimulated to excitement by the blood; which excitement being conveyed to the muſcular fibres of thoſe veſſels, by the nervous fibrillæ diſtributed from thoſe expanſions to the muſcular fibres, will cauſe them to contract, in the ſame manner as other involuntary muſcles are made to contract.

19. The par vagum, then, conveys the

æthereal and phlogiſtic powers to the lungs; when there, thoſe powers are excited by the blood, and with the aſſiſtance of the æthereal and phlogiſtic powers in the blood, produce the vaſcular actions of the lungs, by which the blood is propelled through them to the left auricle and ventricle of the heart.

20. But, as has already been conſidered and explained, (ſect. vii.) the nerves convey both the æthereal and phlogiſtic powers to the muſcles: they require the *blood* to be replete with *both* thoſe *powers* to aſſiſt in producing muſcular action; and the blood muſt contain *both* thoſe powers, to enable it to *excite* the *nerves* expanded upon the ſurfaces of the *blood veſſels*, ſo as to produce the involuntary actions of thoſe veſſels.

21. The blood which paſſes from the right ſide of the heart to the vaſcular extremities of the lungs, is naturally conſiderably exhauſted, or nearly deprived of its acid principle and æthereal power:—that blood, then, can neither

excite the nerves expanded upon the ſurfaces of the blood veſſels, nor enable the powers of the nerves to produce contraction of the involuntary muſcular fibres, with any degree of vigour; becauſe it *wants* the *æthereal power* to co-operate with the phlogiſtic power which it contains.

22. In health, then, the æthereal and phlogiſtic powers flow by the par vagum to the lungs:—thoſe nerves are expanded upon the ſurfaces of the pulmonary veins and arteries, and are expoſed to the influence of the blood; that blood having been exhauſted of its æthereal power, in paſſing through the ſyſtem, cannot excite thoſe nerves to diſcharge themſelves to the muſcular fibres of thoſe veſſels, for *want* of the *æthereal power* to co-act with the phlogiſtic power.—In this ſtate, the nerves *not* being excited to *diſcharge* their powers, and the powers ſtill conſtantly flowing to them from the brain, *thoſe powers* muſt be *accumulated* in thoſe nerves of the lungs;—in conſequence of that accumulation, the *redundant powers* are *commu-*

nicated to the *nerves* of the *muſcles* of *inſpiration*, by connecting branches:—the powers thus communicated *flow* to thoſe *muſcles*: — they contract; the thorax expands: pure air ruſhes into the lungs: the *æthereal power* thus ſupplied to the *blood*, it immediately excites the *nerves* of the *lungs*: they diſcharge their powers to the *muſcular fibres* of the *veſſels*: thoſe muſcles act and propel the blood to the heart; while the nerves of the lungs, being *diſcharged* of their powers, the tranſmiſſion of thoſe powers to the nerves of the muſcles of inſpiration, in conſequence of their redundance, *ceaſes*, and thoſe muſcles ceaſe to act, till the arrival of more blood deprived of æthereal power to the bronchial cells; in which caſe, the powers of the nerves of the lungs will again want excitement, and diſcharge; will again accumulate, and flow to the muſcles of inſpiration; and will again, by cauſing thoſe muſcles to act, procure the admiſſion of pure air to the blood; without which the actions of the lungs, as well as of the heart, brain, and every part of the ſyſtem, muſt ceaſe.

23. It is evident, then, that the phlogiſtic power in the blood cannot, *alone*, excite the involuntary nerves: that for want of excitement, the powers accumulate in the nerves of the lungs; and that the powers thus accumulating are wiſely communicated to the muſcles of inſpiration; by whoſe actions, the blood is ſupplied with that æthereal power which is wanting.

24. Another ſubject of conſideration reſpecting the lungs now preſents.—As the blood which is diſtributed to every part of the body muſt paſs through the lungs, to receive the æthereal air, and as the quantity circulated through the ſyſtem in any given period is increaſed in proportion to the muſcular actions of the ſyſtem, voluntary or involuntary, of neceſſity, the parts muſt be ſo conſtituted, that the *degree* of *action* of the vaſcular extremities in the lungs, ſhall, at all times, be proportionate to the actions of the reſt of the ſyſtem.—That this in reality is the caſe is evident to every obſerver; for, if the involuntary actions of the heart and

blood veſſels be quickened, the actions of the lungs are more frequent; if the voluntary muſcles be put into action, the reſpirations inſtantly become more quick and full; and if even a hand or a foot be *rigidly* ſtretched out, the breathing will be repeated at ſhorter intervals, in conſequence.

25. It is very evident, then, that the nerves called the *par vagum* are connected with *every nerve*, voluntary or involuntary: it is very probable that they are formed of *branches* diſtributed from *every* diſtinct nerve; which branches, compacted together, form the par vagum, or eighth pair, ariſing from the baſis of the brain; or, rather, ariſing from the more *interior* parts of the brain, where the numerous connexions with the other nerves can be more conveniently made: and it is very evident, that the fibres of the par vagum which paſs to the *lungs*, after being thus formed by the other nerves, communicate *within* the brain, with the nerves which ſupply the *muſcles* of *inſpiration*.—In conſequence of thoſe connexions, it muſt follow,

that whenever the æthereal and phlogiſtic powers flow from the brain to any nerve, voluntary or involuntary, a *portion* of thoſe *powers* muſt paſs to the par vagum and to the *lungs*; conſequently, whatever be the *degree* of muſcular exertion in the ſyſtem, the lungs will be made to receive an *equal* flow of thoſe powers, to ſupport their actions;—and the more *copious* that flow of powers to the lungs is, the ſooner they will *accumulate* and regurgitate, or flow into the nerves of the *muſcles* of *inſpiration*, to expand the lungs, and admit pure air, for the purpoſe of exciting the nerves of the lungs to *diſcharge* themſelves in *vaſcular actions*; by which the blood, repleniſhed with the *aerial* influence, may be tranſmitted to *every* part of the ſyſtem, in proportion to the neceſſity there is for it there, to ſupport the muſcular actions.

26. That the nerves of the lungs *do* receive the powers from *every nerve*, diſtinctly, by a communicating *branch*, is abundantly evident from this, that, no *ſingle* muſcle can act, but the actions of the lungs are immediately *in-*

creafed:—if one hand be firmly clofed for a minute, the number of infpirations in that minute will be *greater* than before, *cæteris paribus:* confequently, *every* nerve, fupplying any mufcle, *muft* fend a branch to the *par vagum*, as well as to the intercoftal nerves, as was before explained, fect. ix.

27. The par vagum, then, certainly do receive a proportion of the æthereal and phlogiftic powers, from every nerve arifing in, or from the brain:—they certainly alfo are connected with the nerves of the mufcles of infpiration; and when a certain quantity of thofe powers is received into the nerves of the par vagum, they pafs into the nerves of thofe mufcles, and excite them to contract; by which the lungs are made to receive the air:—if the *difcharge* of thofe powers from the nerves of the lungs be *prevented, entirely*, that accumulation of powers will be more fpeedy and great, and the flow of powers to the nerves of the lungs will be entirely *diverted* to the *mufcles* of *infpiration*

28. That a portion of the powers may *regularly* flow from the par vagum to the nerves ſupplying the muſcles of inſpiration, is poſſible; but, that the æthereal and phlogiſtic powers in the nerves of the lungs, when there is *not* pure air to enable the blood to excite them to diſcharge themſelves, by *accumulation*, flow to the nerves and muſcles of *inſpiration*, and cauſe them to expand the thorax, is inconteſtably evident; even from this *one* conſideration, that the admiſſion of pure air to the lungs, inſtantly *takes away* the *excitement* of the muſcles of inſpiration; and, if pure air be *denied* to the lungs, the flow of the exciting powers to the nerves and muſcles of inſpiration is *rapid* and *exceſſive*; that is, when the powers *cannot* be diſcharged from the lungs, they *paſs off* by the nerves to the muſcles of inſpiration: in ſhort, that the excitement of the nerves and muſcles of inſpiration is derived from the nerves of the lungs I have already proved in par. 9 and 10 of this ſection, and ſhall not further inſiſt upon what is ſelf-evident.

29. There is one obſervation to be made,

of ſome importance, which is this.—The nerves ſupplying the muſcles of inſpiration are ſubſervient to the will:—volition throws thoſe muſcles into action, by tranſmitting a flow of the æthereal and phlogiſtic powers from the brain along thoſe nerves; which flow is kept up by the *vital* or *animating* powers of the nerves correſpondent *to*, and excited *by* the *intellectual* powers of the brain, till thoſe æthereal and phlogiſtic powers are communicated to the material particles in muſcular arrangement in an *excited* ſtate; when, becoming atmoſpheric around thoſe muſcular particles, they attract them together, by means of the powers in the blood, as before more particularly explained.—The *ſame flow* of powers, then, is tranſmitted to the muſcles of inſpiration when they act *involuntarily*; conſequently, when the æthereal and phlogiſtic powers are *not* diſcharged from the nerves of the lungs, for want of pure air, and become *accumulated* in thoſe nerves, till they flow to the nerves of the muſcles of inſpiration by the communicating branches, *thoſe powers*, thus flowing to the nerves of the muſcles of inſpiration, excite the *vital*,

or *animating* powers of thoſe nerves to tranſmit them to the muſcular fibres, and cauſe them to act; conſequently, whether the flowing powers excite the vital or animating principles of the nerves, or thoſe principles be excited to give motion to the powers, ſtill the effect is the ſame; and the excitement of the vitality or animation of a nerve, and the progreſſive motion of its æthereal and phlogiſtic powers are *ſimultaneous* and *mutually* productive of each other.

30. That the nervous powers may be excited to flow along the nerves, in *unuſual quantities*, is evident in various parts of the ſyſtem, on different occaſions; and that thoſe powers may accumulate in thoſe nerves, and *regurgitate*, as it were, into other nerves, ſo as to excite them to act, is not peculiar to the nerves of the lungs alone:—for example, if the nerves of the membrane which is expanded within the noſe, called, commonly, Schneider's membrane, be *ſlightly irritated*, the æthereal and phlogiſtic powers will flow in an increaſed quantity and excitement, and will *diſcharge* themſelves, in exciting the

muſcular actions of the *vaſcular extremities,* to an *unuſual degree*; by which means, the natural ſecretions performed by thoſe veſſels will be greatly *increaſed,* and poured out upon the ſurface of the membrane.

If this ſtimulus upon the nerves be *increaſed,* the flow of æthereal and phlogiſtic powers to thoſe nerves will be ſo rapid and *copious,* that they *cannot* be *diſcharged* by means of the muſcular fibres and the blood circulating with them; the powers then *accumulate,* and flow to the nerves ſupplying the muſcles of the *trunk*; which muſcles they throw into the violent actions, which we call *ſneezing*; an effect ſo well adapted to remove the ſtimulus which thus violently excited the powers to flow. Whether the excited powers paſſed from the naſal nerves to the nerves of the muſcles thus thrown into action, by collateral branches, communicating from the naſal nerves to the other, or they excited the brain to tranſmit the powers to thoſe muſcles by their reſpective nerves, is of no conſequence to determine.—That the naſal

nerves, when highly excited, produce a violent flow of powers to the *muſcles* exerted in *ſneezing*, is evident; that the naſal nerves have a *peculiar connexion* with the nerves of thoſe muſcles, is certain; becauſe the excitement of the naſal nerves does *not* affect the muſcles of the *extremities*, but thoſe concerned in ſneezing *only:* in what part of the brain thoſe nerves are connected, then, is *immaterial*, ſo long as we know, to a certainty, that they are *peculiarly* connected with each other.

31. That the powers actually *regurgitate*, or paſs from the naſal nerves to the nerves of thoſe peculiar muſcles, when they accumulate in the naſal nerves to a certain degree, is probable; becauſe a *ſlight* augmentation of that flow of powers to the naſal nerves, inſtantly produces *increaſed vaſcular* action or ſecretion in the noſe, which *diſcharges* thoſe powers from the nerves without affecting the muſcles; and it is only when the powers are excited to flow to the naſal nerves more rapidly than they *can diſcharge* them, that they paſs to the nerves of the

mufcles connected with them, and by difcharging themfelves from thofe nerves, produce the violent contraction of the mufcles which conftitutes fneezing.

32. It is very evident, likewife, that *one nerve* may, and does, in many inftances, communicate a *portion* of its æthereal and phlogiftic powers to *another nerve*, by a communicating branch, although the *other cannot*, in return, impart a portion of its powers to the *former*; for in the cafe of the nafal nerves, we know that when they are excited, they can communicate a flow of powers to the nerves caufing the mufcles to act in fneezing; but *no flow* of powers along the nerves diftributed to *thofe mufcles*, nor any kind or degree of excitement or irritation of *them*, will be communicated from them to the *nafal nerves*, fo as to produce either fneezing, or any direct increafe of their actions, or of the fecretions effected by thofe actions.

33. The par vagum, then, in many circumftances, greatly *refemble* the intercoftal nerves;

each receives a portion of the powers flowing from the brain by any nerve; becaufe every nerve fends off a communicating branch to both; and both are diftributed to the involuntary mufcles; in confequence of which, the involuntary actions muft always be proportionate to the general degree of action in the fyftem.

34. The par vagum *differ* from the intercoftal nerves in this refpect,—the branches from the voluntary nerves pafs into *ganglia* in the *intercoftals*, before they are diftributed to the involuntary mufcles, or vafcular extremities; and the nerves paffing to the vafcular extremities of diftant mufcles, pafs through ganglia, which render them involuntary and cut off every direct communication between the brain and thofe mufcular parts;—but, on the contrary, the par vagum do *not* pafs through ganglia; they arife from the nerves directly communicating with the brain, and convey their powers, *uninterrupted*, to the parts to which they are diftributed.

35. As the par vagum do not ariſe directly from the ſenſorium, they are *not* ſubject to *volition*; they only receive a *portion* of *all* the powers which do flow from the brain to *all* or *any other nerves*:—neither can the powers they receive, immediately excite muſcular action; becauſe the branches of the par vagum are expanded upon the *ſurfaces* of the veſſels, in the manner of complicated medullary plexuſes; there the powers *ſtop* in their courſe, till they are *excited* by the *ſtimulus* of the *blood*; when they flow along their reſpective fibrillæ, diſtributed from thoſe expanſions on the veſſels, to the muſcular fibres; which, with the aſſiſtance of the powers in the blood, they cauſe to contract.

36. From the preceding conſiderations, I draw the following general concluſions:

1ſt. That the par vagum, or eighth pair of nerves, are formed of branches ſent off from *every* diſtinct nerve, originating in the *brain*;

which branches, collected together, constitute the par vagum.

2d. That whatever be the *quantity* of æthereal and phlogistic powers, flowing from the brain, to any, or all of the nerves, a *certain proportion* of those powers is necessarily transmitted to the *par vagum*, by those collateral *branches* of which they are formed; consequently,

3d. That the *actions* of those parts to which the par vagum are distributed, must, necessarily, at all times, be proportionate to the actions of the system in general.

4th. That considerable branches of the par vagum are distributed to the *lungs*, and expanded upon the *surfaces* of the *vascular extremities* there, so as to be exposed to the action of the blood, and the air also, in the bronchial cells.

5th. That the nerves, thus expanded, receive the æthereal and phlogistic powers constantly

flowing from the brain, in ſome proportion or other; and, that thoſe nervous powers, when excited by the blood, replete with phlogiſticated food and æthereal acid, immediately flow along the nervous fibrillæ to the muſcular fibres, and cauſe them to act; by which, the blood they contain is propelled from the right ſide of the heart, through the lungs, to the left; and the nerves are *diſcharged* of their powers for that time.

6th. That the blood flowing from the heart by the pulmonary *arteries*, being nearly *exhauſted* of its *æthereal* acid, *cannot* excite the nerves expanded on the vaſcular extremities of the lungs, to flow and *diſcharge* themſelves along the muſcular fibres of thoſe blood veſſels.

7th. That the *powers*, thus conſtantly flowing to the nerves of the lungs, from which they are not duly excited to diſcharge themſelves, on account of the *want* of the *æthereal* acid of the air, muſt ſoon *accumulate*, ſo as to prevent any further flow of thoſe powers to the lungs.

8th. That the powers thus accumulated in the nerves of the lungs, do, then, flow by a *lateral* communication to the nerves, diftributed to the *mufcles* fubfervient to *infpiration.*

9th. That by that flow of powers, the muf-cles which dilate the thorax are made to act; and the air rufhes into the lungs, and imparts its influence to the nerves and blood in the bronchial cells.

10th. That the *pure air,* thus received into the lungs, imparting its influence to the *blood,* reftores to it that *æthereal power* which was want-ing; and the nerves of the lungs are, therefore, inftantly excited to tranfmit their powers to the mufcular fibres of the blood veffels; in confe-quence of which, the blood is propelled through thofe veffels towards the left fide of the heart; and the nerves of the lungs are *dif-charged* of their powers.

11th. That the nerves of the lungs being thus difcharged, the collateral *flow* to the nerves

and muſcles of *inſpiration* will be *ſtopped*, and their actions will *ceaſe*.

12th. That the air thus received into the lungs, muſt ſoon be *deprived* of its *æthereal* acid, by the flowing blood exhauſted of its æthereal power by ſupporting the actions of the muſcles in its circulation through the ſyſtem; and, conſequently, that the *ſucceeding* blood will *not* be capable of exciting the nerves to diſcharge themſelves in producing the vaſcular actions of the lungs:—the circulation of the blood will be impeded; the powers of the nerves will accumulate; they will then regurgitate, or flow to the nerves and muſcles of inſpiration; *thoſe muſcles* will be thrown into *action*, and air will, *again*, be received into the lungs, and will diſcharge the nerves; promote the circulation of the blood, and *ſuſpend* the flow to the muſcles of *inſpiration*, which will again *ceaſe to act* as before.

13th. That if pure air be *not* admitted to the lungs, the nerves will *not* be excited to *diſcharge*

their powers along the muſcular fibres of the pulmonary veſſels; thoſe veſſels will not be capable of *propelling* the blood; the powers prevented from flowing off by the nerves of the lungs will be accumulated; and the ſucceeding powers flowing from the brain will entirely paſs to the nerves and *muſcles* of *reſpiration:* in conſequence of which, their actions will become *conſtant* and *exceſſive*; till the *brain itſelf*, being deprived of its conſtant ſupplies of æthereal power, from the blood tranſmitted from the heart after paſſing through the lungs, will be ſo far *impaired* in its functions, as only to tranſmit its powers in occaſional convulſive jets; when, if the æthereal air be not admitted to the lungs, death itſelf muſt ſpeedily enſue.

14th. That, by the nerves of the lungs being thus formed from, or at leaſt receiving branches from, *all* the *other nerves* of *motion* in the ſyſtem, derived immediately from the brain, the powers tranſmitted to the *lungs* muſt ever be *proportionate* to the powers tranſmitted to excite the muſcular actions of *every other* part of the ſyſtem;

and, consequently, the vessels of the lungs will be rendered capable of transmitting as much blood, through the lungs, as is transmitted through all the muscles in the other parts of the body.

15th. And that the nerves of the lungs thus communicating with the nerves of the muscles of inspiration, will impart a flow of the powers to them proportionate to the degree of excitement or muscular action in the system; because the *more rapidly* the powers flow to the nerves of the lungs, the *sooner* will they *accumulate*, and pass to the nerves and muscles of inspiration, if not excited by the blood and æthereal air; and as the blood flowing through the lungs is naturally nearly *exhausted* of its æthereal power, and flows with a rapidity proportionate to the general degree of muscular action in the system, the more rapidly that blood is sent to the lungs, the more frequently must it require the admission of pure air to restore the æthereal power, and enable it to excite the nerves of the lungs to discharge themselves; consequently, the more frequently the

blood *wants* the *æthereal* power to excite the nerves of the lungs, the more repeatedly muſt the *powers* of *thoſe nerves* regurgitate to the nerves and muſcles of *inſpiration* to excite them to act; by which means the blood will acquire the æthereal power from the air, and diſcharge the nerves of the lungs, by exciting them to flow to the muſcular fibres, by whoſe actions the blood is circulated through the lungs to the heart.

By theſe means the *blood*, ſupplied with the phlogiſtic power from the food taken into the ſtomach, acquires the *æthereal power* from the *air*, and then becomes capable of exciting the nerves expanded upon the ſurfaces of the veſſels which convey it, to tranſmit thoſe powers to the involuntary muſcles, and cauſe them to act; by which actions the *blood* is circulated to every part,

To the brain and nerves it imparts its æthereal and phlogiſtic powers; and in the muſcles it is the *medium* by which thoſe powers, excited to flow from the nerves, are enabled to *attract*

the particles of matter in *muſcular arrangement*, together, ſo as to produce what we generally call the *action* or *contraction* of the *muſcles*; by which attraction alſo, the æthereal and phlogiſtic powers combining together, form *animal heat*; which, at all times, is, therefore, proportionate to the muſcular actions of the ſyſtem.

But, the blood requires frequent ſupplies of *phlogiſton*, as well as of the æthereal power; in conſequence of which, *proper food*, containing the *phlogiſtic power*, is as neceſſary as pure air; the next conſideration, therefore, is—The digeſtive powers of the ſtomach and inteſtines, by which the blood is ſupplied with the phlogiſtic power combined with the antacid principle.

SECTION XII.

On the digeſtive powers of the ſtomach; and the manner in which the appetite for food is excited, in conſequence of a deficiency of the phlogiſticated principle in the blood.

1. IT has already been obſerved, (ſect. ii. and iii.) that the reception of proper food into the ſtomach, is as neceſſary to ſupport the functions of the brain, and the ſanguiferous and muſcular actions, as the admiſſion of proper air into the lungs is; and, that nothing is capable of affording proper nouriſhment, but what does contain the *phlogiſtic power* in a ſtate of ſlight combination, and in a greater proportion than the æthereal power.

2. It has already been obſerved, (ſect. vii.) that all actions or motions in the ſyſtem, are effected by muſcular fibres: that muſcular fibres are made to contract by the powers of the nerves: —that the nerves convey both the æthereal and phlogiſtic powers; and that thoſe powers cannot,

naturally, be excited by the blood, to produce the involuntary actions of the fyftem, unlefs the blood itfelf *contains* both the *æthereal* and *phlogiftic powers.*

3. It has likewife been obferved, that the æthereal power is obtained from the air, in its ftate of arrangement around the acid principle; and that the phlogiftic power, when in proper ftates for affording nourifhment to the body, is combined with the antacid principle in fome ftate, or proportion, or other. The antacid principle, then, in thofe ftates of connexion with the phlogiftic power, which are proper for nutrition, may be called, for the fake of conveniency, the *phlogifticated principle.*

Here let me obferve, that *antacid principle* is the general term for the *contrary* to the *acid, principle,* whatever be its ftate; and, therefore, it includes the carbon, azote, and hydrogen of the French fchool, which are only *varieties* of the *fame principle,* with *different* proportions of the *phlogiftic* power.

4. By the wife contrivance of nature, the

world is ſo conſtituted that the antacid, alkaline, or earthy principle, with the phlogiſtic power, exceeds in proportion, the acid principle and its æthereal power, in general, in the animal, vegetable, and mineral ſyſtems; in all of which the *phlogiſtic power* particularly *abounds*, but is ſo complicated with the other power and principles, as to be condenſed into ſtates more or leſs ſolid, by chemical combination; on the contrary, the *Atmoſphere alone*, is the grand and general ſource of *æthereal power*, and in few other ſtates do we meet with it in an over proportion: conſequently, the animal and vegetable kingdoms in particular, may afford numerous articles capable of ſupplying the blood with the phlogiſticated power, combined in various proportions with the other principles; but, *pure air*, *alone*, is capable of affording the æthereal power in ſuch a ſtate as is adapted to the lungs, and in ſuch proportion, as the blood requires to enable it to ſupport the functions of the brain, and to excite the two powers in the nerves.

5. As the *phlogiſtic power* is capable of being

combined with the material principles in *very great* proportions, and is commonly found in thoſe proportions in various ſubſtances, it is evident, that by means of certain aliments, the blood may be ſupplied with the phlogiſtic power in *great proportions* and quantities; and that this is the caſe, is abundantly evident from this ſingle conſideration, that a man, well fed and in good health, is capable of living and exerciſing all his functions, for ſeveral days, without any *freſh ſupply* of food to the ſtomach; he breathes, ſuppoſe about twelve or fourteen hogſheads of air in one day; the blood contains phlogiſtic power enough to combine with and ſaturate, or nearly ſo, *all* the *pure air* in that quantity of atmoſpherical air; conſequently, were he to live ſeven or eight days without food, the blood muſt have contained as much phlogiſtic power as would be ſufficient to ſaturate, or nearly ſaturate, *one hundred hogſheads* of *atmoſpherical air*; a great part of which would be changed into *fire* or *heat*, as in caſes of common combuſtion.

6. This being the caſe, the blood does not require ſuch *frequent* ſupplies of the phlogiſticated

principle, as it does of æthereal acid, or pure air; and we muſt now conſider in what manner the ſyſtem is excited to provide occaſional ſupplies of the phlogiſticated principle, when that principle is, to a certain degree, *exhauſted*; or when the phlogiſtic power begins to be deficient in the blood.

7. The *ſtomach* is the receptacle of the food which is taken to ſupport the ſyſtem; and the inteſtines, liver, pancreas, ſpleen, lacteals, meſenteric glands, &c. &c. are all employed in diſſolving the aliment; in ſelecting the nutrimental parts; in expelling the uſeleſs matters, and in conveying what is proper for the ſupport of the body to be mixed with the blood.

This proceſs is performed by means of various fluids, ſecreted by glands of different deſcriptions, and by various vaſcular actions in every part of the chylo-poietic viſcera.

8. The various, extenſive, and conſtant actions of the abdominal viſcera are *involuntary*,

and require a conſtant and copious ſupply of the *nervous powers* to perform them, and of *blood*, replete with the *æthereal* and *phlogiſtic powers* to excite them, and to aſſiſt in the action of the *muſcular fibres*, by which thoſe involuntary actions are performed.

9. The nerves which convey the æthereal and phlogiſtic powers to thoſe parts, are the *intercoſtals* and the *par vagum*. Both theſe pairs of nerves are chiefly, if not entirely, formed of *branches* ſent off from *all* the other *nerves of motion*, immediately connected with the brain: both of them receive a flow of the æthereal and phlogiſtic powers, in proportion to the *degree* of *action* in *any* or *every* part of the ſyſtem; and, conſequently, the actions of the ſtomach, bowels, &c. as well as of the heart and lungs, muſt correſpond with the degree of action in the ſyſtem.

10. That this is the caſe is too evident, from daily experience, to admit of a doubt; and it was wiſely ordained; for as the blood is exhauſted of its powers in proportion to the degree of action in the ſyſtem, the actions of the ſtomach

and lungs, by which thoſe powers are reſtored to the blood, muſt be, at all times, proportionate to the actions which expand them, otherwiſe diſorder muſt enſue; and the beſt means of keeping up that balance, was to ſo order it, that the very nerves which convey the powers of action to the muſcles of volition, ſhall *tranſmit* a *juſt proportion* of thoſe powers to the *nerves* which act for the purpoſe of *providing ſupplies* of thoſe powers to the ſyſtem at large.

11. The *vaſcular actions* of the ſtomach, inteſtines, liver, ſpleen, pancreas, lacteals, meſentery, &c. are very great and numerous; and the quantity of *nervous powers* neceſſary to perform thoſe various and extenſive actions, muſt be great indeed; conſequently, the quantity of *blood*, duly ſupplied with the æthereal and phlogiſtic powers, muſt be *conſiderable*, to afford *excitement* to thoſe nerves, ſo as to make them *diſcharge* their powers along the *muſcular fibres*, and cauſe them to *contract.*

12. As the proportion of æthereal and phlo-

giſtic powers flowing conſtantly to the nerves of the abdominal viſcera, muſt be great, and as thoſe powers are only excited to act by the *ſtimulus* of the powers in the *blood*, or *fluids* acting upon them in their ſtates of *expanſion* upon the *interior ſurfaces* of the blood veſſels, or glands, it is evident, that when the blood becomes *exhauſted*, to a certain degree, of its *phlogiſtic power*, it *cannot* excite the nerves to *diſcharge* their powers ſufficiently; in conſequence of which, the *vaſcular actions* of the abdominal viſcera will be *imperfectly* performed, and the circulation *impeded.*

13. When, therefore, the phlogiſticated principle becomes *deficient* in the blood, the actions, and ſecretions of the abdominal viſcera will be *diminiſhed.*

If, in this ſtate, any proper food, or phlogiſtic matter be taken into the ſtomach, that *phlogiſton* being applied to the nerves of the ſtomach, where the blood duly ſupplied with the æthereal power is preſent, will with the *conjoint influence*

of that *æthereal power*, immediately *excite thoſe nerves* to tranſmit their powers to the *muſcular fibres*; and the *vaſcular actions* will be *reſtored* to their *due degree* of power and efficacy.

14. As the flow of *thoſe powers* to the nerves of the ſtomach is *conſtant*; as it is proportionate to the degree of action in the ſyſtem in general; and as the deſire for food is in proportion to the actions of the ſyſtem, it is evident, that the *ſenſation of hunger*, or the *deſire for food*, is produced by *thoſe powers* in the nerves, or by the *quantity* of *them* preſent; becauſe, the moſt *ardent deſire* for food may be immediately *extinguiſhed*, by taking *phlogiſtic* ſubſtances of certain kinds into the ſtomach; that is, the phlogiſton thoſe ſubſtances contain, with the æthereal power in the blood, together excite thoſe nerves to *diſcharge* themſelves.

15. It is clear, then, that when the phlogiſtic power is *deficient* in the blood, and the nerves of the ſtomach are *not diſcharged* of their powers, that *accumulation* of powers excites, or is the cauſe

of there being excited, in the nerves, the *ſenſation of hunger*, or the *deſire* for *food.*

16. The *nerves* of the ſtomach, then, are *involuntary* in their actions, but ſtill capable of communicating and exciting the *ſenſation* of *hunger* in the brain; they, therefore, have ſome *peculiarity* which diſtinguiſhes them from the involuntary nerves of the heart and blood veſſels, in common;—from whence then are they derived? —in what does that difference conſiſt?

17. The nerves of the heart and vaſcular extremities are chiefly ſupplied from the intercoſtals, and ariſe from *ganglia*, which *cut off* immediate communication with the brain; but, the nerves of the *ſtomach* are chiefly derived from the *par vagum*, which have *no intercepting ganglia.*

18. Both the nerves of the intercoſtals and par vagum, are *expanded* upon the *ſurfaces* of the *veſſels*, and then terminate in the *muſcular fibres*, which renders them *only* excitable by the application of *ſtimuli* to thoſe *expanſions*; but,

when a ſtimulus is applied to the expanſions of the *par vagum, that* excitement may be communicated to the brain itſelf, as there are *no* interrupting ganglia.

19. That this is in reality the caſe, is rendered obvious by many conſiderations, and none is more convincing than the inſtantaneous excitement which is communicated to the brain and the whole ſyſtem, when exhauſted by fatigue, by the taking *wine* or *ſpirits* into the *ſtomach*. The *phlogiſtic power* in thoſe liquids inſtantly excites the *nerves* of the ſtomach to *diſcharge* themſelves in actuating the *muſcular fibres*; and the excitement of the *nerve* is inſtantly communicated to the *brain*, and to *every nerve* in the ſyſtem, with which the par vagum are connected.

20. When the formation of the par vagum was under conſideration, in the ſection on reſpiration, it was concluded, that the *par vagum* were formed of *branches*, *ſent off* from *all* the nerves of motion, derived immediately from the brain; conſequently, though the par vagum

do not immediately arife from the centre of volition in the brain, ftill, they are fimply *connected* with *all* the *nervous origins* in the brain; and, as the nerves have a peculiar *vitality* or *animation*, which rapidly conveys impreffions when thofe nerves are free from interruption, it is evident, that when the nerves of the ftomach are excited to a fufficient degree to conftitute fenfation, *that excitement* will be inftantly communicated to *all* the *nerves* from which they arife, and from them to the *brain*; fo that the *ftate* of the nerves of the ftomach is inftantly *communinicated* to *all* the *nerves* of *motion*, and to the *brain itfelf*.

21. This ftatement is corroborated by many other facts; for we know that certain ftates of the ftomach do affect even the voluntary mufcles, in fuch manner as to render them active, in oppofition to the will, as in fpafms and convulfions, which arife from the *nerves* of the *ftomach* being irritated and excited, and from that irritation and excitement being communicated to the *nerves* of *volition* from which they arife.

22. The branches of the par vagum which are diſtributed to the *ſtomach*, are not the *only nerves* which communicate their vital or animated excitement to the brain, becauſe, the inteſtines themſelves, are capable alſo of communicating certain ſenſations when ſtrongly excited; and thoſe branches which paſs to the *lungs*, have the ſame power, as is evident from the coughing excited by irritating the lungs; from the ſenſation of oppreſſion when pure air is withheld; from the pleaſing relief which the admiſſion of pure air to the lungs affords; and from the excitement which the pure air communicates to the brain by the connecting nerves in certain caſes of ſuſpended animation; for, when the functions of the brain, and the actions of the lungs have ceaſed, the excitement which pure air gives to the nerves of the lungs, is communicated by the vital powers of the nerves to the brain, and its functions are revived; the powers put in motion; the muſcles of reſpiration thrown into action; the nerves of the lungs diſcharged, and life reſtored.

23. The ſtomach, then, receives its nerves, *chiefly*, from the par vagum ; and when the powers flowing conſtantly into thoſe nerves from the brain, are not *duly diſcharged* for *want* of the *phlogiſtic power* in the *blood*, thoſe powers *accumulate* and flow, more particularly, into the *nerves* which are diſtributed to the mouth, the tongue, the ſalival glands and muſcles of deglutition, by a peculiar communication, ſimilar to what takes place between the branches of the par vagum ſent to the lungs, and the nerves diſtributed to the muſcles of inſpiration ; as is evident from the degree of tenſion, of action, of excitement, of deſire for food, and from the copious ſecretion of ſaliva which accompanies that deſire and the ideas which it excites.

24. It is very evident that the blood in the ſtomach and inteſtines, and their glands, and in their large appendages of the liver, pancreas, &c. muſt require a *great degree* of *muſcular action* in the *veſſels themſelves* to circulate it : that muſcular power muſt be derived from the nerves ; thoſe nerves muſt be excited by the blood ; and

that blood, to be capable of exciting them, muſt poſſeſs *both* the *æthereal* and *phlogiſtic powers*, in certain proportions, otherwiſe the powers muſt *accumulate* in the nerves, and the circulation muſt become *ſlow* and *difficult*, for want of muſcular action. Whenever, therefore, the æthereal power is wanting, nature hath wiſely contrived that the powers, not being diſcharged from the *nerves* of the *lungs* for want of æthereal air, muſt *regurgitate* to the *nerves* and *muſcles* of *inſpiration*, by which means pure æthereal air is brought to the blood: and whenever the *phlogiſtic power* is wanting, it is ſo contrived, that the *powers, not* being *diſcharged* from the nerves of the ſtomach for want of phlogiſtic power, muſt *partly regurgitate* into the nerves ſupplying the tongue, mouth, fauces, and their peculiar glands, accompanied with the *ſenſe of hunger*.

25. As the lungs and ſtomach are peculiarly deſtined to ſupply the ſyſtem with the air and food, without *both* which life *cannot long* be ſupported, it is neceſſary their actions ſhould be regulated by the *wants* of the ſyſtem, or its *ex-*

penditures; and that, in caſes of danger, the intellectual power itſelf ſhould be alarmed, and the aſſiſtance of reaſon called in; for which purpoſes, the par vagum are connected with *all* the nerves ariſing from the brain, and receive a flow of the æthereal and phlogiſtic powers, *proportionate*, at all times, to the flow to the *reſt* of the *ſyſtem*; and the intercourſe between the brain and extremities, or expanſions of the par vagum, is *not* interrupted by *ganglia*, as is the caſe with the intercoſtal nerves; in conſequence of which, powerful irritations or excitements of thoſe *nervous expanſions*, are communicated to the *brain*; more particularly ſo when the powers are accumulated there, while the functions of the brain are unimpaired; and, likewiſe, by this *free* courſe of the par vagum, when ſudden exertions or mental emotions excite a rapid flow of powers by the nerves, a ſudden flow muſt, *alſo*, paſs to the lungs, ſtomach, heart, inteſtines, and every part to which the par vagum are diſtributed; in conſequence of which, the *uſual ſtimuli* will inſtantly produce a *greater action*, and at *ſhorter intervals*, till the increaſed flow is *exhauſted*.

26. But, the ſimple vaſcular actions propelling the blood in a circuitous courſe, is not all which requires conſideration, reſpecting the ſtomach. The *glandular actions* and *ſecretions*, and the conjoint effects of the blood, the aliment, and the nerves, require attention. They, indeed, require more attention than is compatible with my preſent plan; and I ſhall, therefore, only conſider them in a general point of view.

27. The *glands* of the *ſtomach* are formed of arteries and veins, conveying blood, and of nerves giving motion to the muſcular fibres in their texture. But, in theſe glands, the *blood itſelf* is *decompoſed*, which can only be effected by the *æthereal* and *phlogiſtic powers* flowing off from the extremities of their reſpective *nervous fibrillæ*, in a ſtate of *ſimple expoſure* to the blood, or other fluids having acceſs to them, *without* being *connected* with *muſcular fibres*.

28. In this ſtate of *ſimple termination*, the nerves are readily *excitable* by the blood or fluids acting on their extremities, and, as readily com-

municate *that excitement* to the *brain*;—and, as both the *æthereal* and *phlogiſtic nerves* are *ſimply expoſed*, it is evident, that the *degree* of excitement imparted to *either*, will *vary* as the *qualities* of the exciting *fluids* vary; and, conſequently, that *either* of them may be *particularly excited*, while the *other* is *leſs* excited than uſual.

29. It muſt likewiſe follow, that when the *æthereal* nerve is *more* excited than the phlogiſtic, the *flow* of the *æthereal power* from *that* nerve, into the *blood* or exciting fluid, will be *greater* than the flow of the phlogiſtic power; and, conſequently, that the *change* produced in *thoſe fluids* will be *different*, from what is effected when their excitements are equal, and *vice verſa*; and, it muſt likewiſe follow, that the *ſenſations* excited and communicated to the brain, *muſt vary*, as the *relative excitements* of the two powers become *different* in degree.

30. The nerve which conveys the æthereal power, has a vital principle, which, when excited, imparts *motion* to that æthereal power;

confequently, it is natural to fuppofe, that the æthereal power *in motion* will excite the *vital principle* of that nerve; the vital principle and æthereal power being mutually fubject to each other's influence. For the fame reafon, the *animating* principle of the nerve which conveys the phlogiftic power, muft be excitable by the *phlogiftic power* in *motion* in the *blood*.

31. But although the *phlogiftic power* in the *blood*, is capable of exciting the *animating principle* of the nerves which naturally *convey phlogifton*, it is not capable of receiving and *combining* with that phlogiftic power of the nerves; it merely *excites* the *animating* principle of the nerve, which excitement is communicated to the brain; but, the phlogiftic power of that nerve cannot be *difcharged*, unlefs the contrary *power*, or the antacid *principle*, be prefent to receive it. By that excitement, however, the power of the nerve is ready to *act* with *energy*; and if the *contrary power* be prefent to receive it, it will *flow* from the nervous extremity and *combine* with that contrary power in the exciting fluid: but, if

the contrary power be *not* there in *fufficient quantity* to faturate it, it will be excited to *arrange* itfelf around the *antacid principle* in the *blood*, or to enter into fuch a ftate of *combination* as the circumftances will allow. In the fame manner, the *vital* principle of the *æthereal* nerve may be excited by the *æthereal* power in the *blood*; in which cafe, the *æthereal powers* will flow from the nervous extremity, and *combine* with the *phlogiftic* power if prefent in the blood in fufficient quantity; or, it will combine with the *acid principle* in the ftate of *arrangement*, or fuch a ftate as the circumftances will admit of.

32. We know that when the blood is fully fupplied with the phlogiftic powers, and the actions of the ftomach, &c. are duly excited, the defire for food is not perceived; but, when the *phlogiftic* power is confiderably *expended*, the appetite returns, and increafes, in proportion as the phlogiftic powers become *deficient*: the *powers* fent to the nerves of the ftomach and *not difcharged*, then, *excite* the *fenfation* of *hunger*: —but the nerves of involuntary motion in the

heart and vaſcular extremities of *other* parts, are *not excited* to *ſenſation* by the *accumulation* of their powers; therefore, it is reaſonable, from analogy, to ſuppoſe, that it is not the *accumulation* of powers in the nerves which are diſtributed to the *muſcular fibres* of the arterial and venous extremities, which immediately communicates to the brain the excitement of *deſire* for *food*, but, that it is the *powers accumulated* in *thoſe nerves*, which, without *any* connexion with muſcular fibres, *ſimply terminate* in the *glands* of the *ſtomach*, and are expoſed to the *influence* of the *blood*, and of the *fluids* ſeparated *from it*, *which* excite the ſenſation of hunger or deſire for food: and, as the appetite increaſes as the phlogiſtic power becomes deficient, to a certain degree, and as the nerves of involuntary action in the ſtomach become *ſurchaged* with powers, for *want* of phlogiſtic excitement, it is probable, that the *powers* accumulating in the *nerves* of *motion* of the ſtomach, *communicate* with, and *diſcharge* themſelves, in *part*, by the *nerves* thus ſimply terminating in the *glands* and *inner ſurface* of the ſtomach. If the phlogiſtic power be ex-

hausted to a great degree, the functions of the brain and nerves will be impaired, and the powers of the stomach, of course; in consequence of which, the secretions will be *imperfect*, and the power of *digestion* confined to a small extent; but at present I am only considering the consequences of *temporary abstinence*, which does not proceed so far as to produce any material change in the œconomy of the brain and nervous system, n general.

33. If, then, a man, in health, be kept from food, but duly supplied with air, at first, he will find no inconvenience. The blood circulating to the brain, excites it to transmit a regular flow of the æthereal and phlogistic powers to all the nerves; those nerves communicate a portion of those powers to the par vagum; and part of the nerves which constitute the par vagum pass to the stomach. The nerves which are thus distributed to the stomach have *two* modes of *termination*; *one portion* of them are expanded on the *extremities* of the *blood vessels*, and, being excited by the *blood*, communicate their powers by ner-

vous fibrillæ to the *muſcular fibres* of thoſe veſſels, and excite them to act; the *other portion* of thoſe nerves, *terminate*, ſimply, in the *glands*, where their extremities are expoſed to the *chemical action* of the *blood*.

34. While the blood, then, *abounds* with the *phlogiſtic* power, the powers flowing to the ſtomach are duly diſcharged, and the blood is freely circulated.—But, when phlogiſton begins to be conſiderably *expended* and *deficient*, the nerves of the *vaſcular* extremities are not ſufficiently excited to *diſcharge* themſelves: ſo long as the functions of the brain are duly ſupported, and its powers abound, the flow of powers to the nerves of the ſtomach muſt continue, ſo long as thoſe powers flow to any other part; they muſt, therefore, *accumulate* in the nerves ſupplying the muſcular fibres of the ſtomach; and the flow of the powers will, then, be *chiefly diverted* to the *nerves* which *terminate* in the *glands*.

35. Theſe nerves, ſimply terminating in the *glands* of the ſtomach, and having no *ganglia* in-

terrupting them, in their courſe from the brain to the glands, by this *increaſe* of powers will become *more ſenſible*, and likewiſe more capable of *decompoſing* or *changing* the *blood*, by being excited to *diſcharge* their reſpective powers *into it* : they will, therefore, be more *excitable*, and will diſcharge thoſe powers into the blood, in *greater quantities*; in conſequence of which, a *greater* proportion of the *blood* will be *changed* in its properties; and thoſe newly-acquired properties will alſo be more evident and efficacious, as the powers upon which they depend are more copious; to a certain extent.

36. In this ſtate, the *glandular nerves* of the ſtomach will communicate their *peculiar excitement* to the brain, where it will be perceived in the ſenſation of *hunger*, or the *deſire* for *food*; ſo that the flow of the æthereal and phlogiſtic powers from the nerves of involuntary motion in the ſtomach, being *prevented*, for *want* of *phlogiſtic power*, by this contrivance is made to *ſecrete* a *peculiar fluid* from the blood, which is capable of *diſſolving* thoſe ſubſtances, proper for food,

when taken into the ſtomach; and at the ſame time, the ſenſation of hunger is excited, by which man is powerfully urged to procure ſuch food as is calculated to gratify that deſire, and to reſtore to the ſyſtem *that phlogiſtic power*, which alone is capable of removing the preſent ſtate of excitement of the nerves of the ſtomach and of the brain, induced by the *want* of it.

37. It would carry me beyond my preſent purpoſe, to enter into a minute diſcuſſion of the chemical effects produced upon the blood and elementary ſubſtances in the ſtomach and inteſtines, and to inveſtigate the chemical properties of the fluids ſecreted by the liver, ſpleen, pancreas, &c. I ſhall, therefore, only juſt obſerve, that as the ſecretions of the glands of the ſtomach are particularly excited to activity, by the *want* of *phlogiſtic power* in the blood, the *æthereal power* muſt, when the phlogiſtic power is conſiderably exhauſted, be *moſt copious*; and the *æthereal nerves* of the glands will be *moſt excited:* but, as there is *not* any ſuperabundance of looſely combined *phlogiſton* in the *blood*, the *æthereal power* excited

to flow from thoſe glandular nerves, will be *attracted* to *arrangement* by the *acid principle* in the blood, which will, therefore, acquire a *large proportion* of the *æthereal power*; and, in this ſtate, it will *paſs* into the *ſtomach*, *ſlightly* connected with the antacid principle with its *diminiſhed* proportion of phlogiſton : this *gaſtric fluid*, thus formed, will, when phlogiſtic aliment is taken into the ſtomach, immediately act upon it: the *acid principle* with its *abundant æthereal* power, will attract the *antacid* principle of the *aliment*, and combine with it, and with a *portion* of its phlogiſton; while the *ſuperabundant phlogiſton* which all nutrimental ſubſtances contain, will be *attracted* to *arrangement* by the *antacid* principle of the *gaſtric fluid*, with its *ſmall* proportion of *phlogiſton* ; by which means, that *antacid* principle will become again *highly phlogiſticated*; and, mixing with the reſt, will form a *neutral compound*, containing a *large* proportion of *phlogiſtic* power in a ſtate of looſe combination, fit to be received into the blood, and to reſtore to it its eſſential properties.

38. When the blood is *deficient* to a *confiderable* degree in the phlogifticated principle, and the *acid* principle abounds, the nerves of the glands fecrete from the blood, the *acid* principle with the *æthereal* power in *fuch* proportions and ftates of combination as to conftitute an *actual acid*, as is evident in certain cafes of dyfpepfia, and diabetes; and, on the contrary, when *phlogifton greatly abounds*, as after taking large dofes of opium or fpirituous liquors, or when the *acid* principle is *deficient*, as in the fcurvy, the nerves and fecretions of the ftomach, are in fuch ftates as to be capable of combining with and faturating *large quantities* of the *acid principle*.

39. The blood, thus deprived of a confiderable part of its acid principle in the glands of the *ftomach* and *bowels*, will *retain* an *unufual* proportion of the *antacid* principle, and in that ftate it will be conveyed by the vena portarum to the *liver*; there being expofed to the nervous extremities, in the glands of that vifcus, it will of courfe, excite the *phlogiftic nerves* of thofe glands in particular; they will impart a flow of the phlogiftic

power, which will render the *redundant* particles of the *antacid* principle *highly phlogiſtic*; in which ſtate they will paſs off by the biliary ducts, combined, however, with a certain *ſmall* proportion of the *acid particles* ſtill remaining in the blood, in which ſtate they will form the *bile*, a fluid replete with the phlogiſticated principle, which being conveyed into the duodænum, will mix with the alimentary compound flowing from the ſtomach; when part of that bile will paſs along with the compound chyle into the blood, and part will remain combined with the uſeleſs or ſuperfluous parts of the aliment, whoſe expulſion it will aſſiſt, by its phlogiſtic excitement co-acting with the æthereal excitement of the blood, to *excite* the *nerves* of the inteſtinal canal, to keep up the regular actions of the *muſcular fibres* of thoſe parts.

40. When aliment containing a large portion of the phlogiſtic power is, then, received into the ſtomach, thus excited and thus ſupplied with the fluid ſecreted by the gaſtric glands in conſequence of a deficiency of phlogiſton in the

blood, various effects are produced:—the aliment is attacked by the *two contrary* principles of the gastric fluid: the *acid* principle with its *æthereal* power attracts the *antacid* principle of the *aliment*, while the antacid principle of the *gastric solvent* attacks the *superabundant phlogiston* of that aliment to which it has a strong attraction of *arrangement* in its present *impoverished* state: by this double attack the alimentary matters are *decomposed*, and the *phlogisticated principle* is subjected to the attractive actions of the lacteals. When the *phlogistic* power of the *aliment* is thus *evolved*, it acts also upon the nerves of the stomach; its *phlogistic* principle with the *æthereal* power of the *blood* in the vascular extremities, excite the *involuntary nerves* of those parts to impart *motion* to the *muscular fibres*, by which those nerves become *discharged* of their powers, and the blood is *propelled* with freedom; and at the same time, this *phlogistic* power, now *abundant*, excites the *animating* principle of the phlogistic nerves of the glands, which being communicated to the *brain* excites it to perform all its functions with *renewed energy*; while the quickened circula-

tion affords it more copious ſupplies of blood, from which it derives all its powers : and it is highly probable, that the *blood itſelf*, which circulates through the veſſels of the ſtomach and inteſtines, does actually acquire a copious ſupply of the phlogiſtic power, when expoſed to the influence of that fluid or power diſengaged by the gaſtric ſolvent from the alimentary matters taken into the ſtomach, a conſiderable portion of which it retains, when tranſmitted from the liver to the heart, to be tranſmitted through the lungs to the brain and the reſt of the ſyſtem, upon the ſame principles as it attracts the æthereal power from the air, in paſſing through the lungs.

But not to enter more minutely into a ſubject of ſuch wide extent, at preſent, I ſhall cloſe this ſection by drawing the following general concluſions :

1ſt. That the ſtomach is ſupplied with nerves, chiefly from the par vagum.

2d. That thoſe nerves ariſe from all the nerves

of motion proceeding from the brain;—confequently,

3d. That the flow of the æthereal and phlogiftic powers to the ftomach, is, at all times, proportionate to the flow to the other nerves; and, therefore, to the degree of action in the fyftem.

4th. That the nerves of the ftomach are partly diftributed to the vafcular extremities, where being excited by the powers in the blood or other fluids, they produce thofe mufcular actions by which the blood is duly circulated.

5th. That other branches of thofe nerves are diftributed to the *glands* of the *ftomach*, in which they *fimply terminate*; being expofed to the influence of the blood or fluids in the ftomach, without any immediate connexion with mufcular fibres.

6th. That when the *phlogiftic* power becomes *deficient* in the *blood*, the nerves of motion are

not duly *difcharged*, for want of the phlogiftic excitement; and the blood, of courfe, is circulated with difficulty.

7th. That in confequence of this want of excitement, the powers *accumulate* in the nerves of motion, and flow, in an increafed proportion, to the nerves diftributed to the *gaftric glands*.

8th. That the nerves of the glands, thus copioufly fupplied with the æthereal and phlogiftic powers, are *ftrongly excited* by the blood in thofe glands.

9th. That that excitement is communicated to the brain, by thofe nerves being free from the interruption of ganglia; and there it produces the *fenfation* of *hunger*, or the defire for food.

10th. That the nerves of the glands thus excited and abounding in the two powers, *difcharge* thofe *powers* in an *excited ftate* into the *blood*, with which they combine in various proportions, and produce *chemical changes*, from which arifes

a *fluid ſecretion*, which paſſes into the ſtomach, and is called the *gaſtric fluid.*

11th. That this fluid has the property of *diſengaging* the *phlogiſticated principle* of the *aliment* taken into the ſtomach, and of combining with it, ſo as to form *chyle*, or a compound in which the *phlogiſticated principle* forms a *conſiderable part*, and is *ſo evolved* as to be capable of exerting its ſpecific powers, and when received into the blood, of *reſtoring* to it its *phlogiſtic* properties, and power of *exciting* the *muſcular* actions of the ſyſtem.

12th. That the *phlogiſtic* power thus evolved in the ſyſtem, immediately, with the co-operation of the æthereal power in the blood, excites the *vaſcular actions* of the ſtomach, &c. and diſcharges thoſe nerves of motion of their accumulated powers; by which the blood is again circulated with freedom to the heart.

13th. That, at the ſame time, it excites the *animating power* of the phlogiſtic nerves; which

excitement being communicated to the brain, is again tranſmitted to *every part* of the ſyſtem; in conſequence of which, all the functions of the brain and nerves are performed with *increaſed energy*.

14th. That, at the ſame time, that the animating principle of the brain and nerves is excited by the phlogiſtic power in the ſtomach, the *motion* of the *blood* is *accelerated*, and furniſhes powers in proportion to the excitement of the animating principle.

15th. That the nerves of the ſtomach have a peculiar communication with the nerves diſtributed to the tongue, ſalivary glands and muſcles of maſtication and deglutition; in conſequence of which, when the nerves of the ſtomach are peculiarly excited by the accumulation of powers, a portion of thoſe powers is tranſmitted to the nerves of the mouth, fauces, ſalivary glands, &c. by which they are peculiarly excited alſo and ready to aſſiſt in preparing food for the ſtomach.

16th. That by theſe means the *appetite* for

food containing the phlogiſtic power, and the *power* of *digeſting* it, is proportioned to the *expenditure* of that peculiar power by the muſcular actions of the ſyſtem; the *defect* of phlogiſtic power in the ſyſtem producing ſuch an *accumulation* of powers in the nerves of the ſtomach, as *excites* the *deſire* for phlogiſtic food, which can only be *ſatisfied* with the application of proper *nutriment* to the ſtomach, already provided with a ſolvent capable of rendering that food fit to reſtore to the blood *that phlogiſtic power* it is in want of.

Having thus taken a general view of the natural functions of the ſtomach, the lungs, the brain and nerves, the heart and ſanguiferous veſſels, and of the muſcular fibres, and the manner in which thoſe functions are excited and exerted, I ſhall not enter upon any more minute conſideration at preſent:—theſe are the moſt important parts of the ſyſtem, and to enter upon the operations of leſs conſequence would extend this tract beyond the bounds I intended.

The blood, however, is of too great import-ance to be overlooked; I ſhall, therefore, devote the next ſection to a few obſervations upon it.

SECTION XIII.

On the blood.

1. THE blood is the grand circulating medium, from which all the powers of the ſyſtem are derived; by the aſſiſtance of which moſt of its operations are performed, and by whoſe motion and active qualities many of the actions of the ſyſtem are excited.

2. The blood, naturally, contains a *large* proportion of *phlogiſtic power* attached to its antacid principle; but to give it a due degree of firmneſs or conſiſtency, and to enable its antacid principle to retain the phlogiſtic power in great proportions, a certain quantity, or proportion, of the acid principle with its æthereal power in a minor proportion, are neceſſary.

3. That the blood does contain a large excefs of phlogiftic power in a natural healthy ftate, is evident from what has already been obferved, (fect. xii. par. 5.) that a man in health confumes twelve or fourteen hogfheads of atmofpheric air in a day; confequently, as a man may live feveral days without food, and as the air is confumed nearly in the fame manner as by combuftion, it is evident, that the blood muft contain as much phlogiftic power, in a man in good health, as would decompofe nearly, or perhaps entirely, one hundred hogfheads of common atmofpheric air, by combining with the æthereal acid of the air, and converting it into fire, and partly into fixed air.

4. From this confideration, it is evident, then, that in common life and health the blood *does contain* a *large excefs* of *phlogiftic power*, in confequence of which it is capable of fupporting the functions of life for a confiderable time, *without frefh fupplies*; but that time is limited, and food muft again be fupplied, or death will enfue.

5. The blood, however, requires conſtant ſupplies of the æthereal acid, from the lungs, as well as of the phlogiſticated principle from the ſtomach, as is evident from the fatal effects ſo quickly ariſing upon the excluſion of air from the lungs; the æthereal air being as neceſſary in the blood to ſupport the functions of life, as it is to ſupport the burning of a taper.

6. The blood being a compound in which the phlogiſticated principle abounds, will, naturally, attract the æthereal acid of the atmoſpheric air in the lungs, as it evidently does; acquiring a more florid colour and more exciting powers than it naturally poſſeſſes when without the æthereal acid.

7. But when the antacid principle in the blood attracts the acid principle of the air, it *loſes* its power of *retaining* ſo *great* a proportion of *phlogiſton*: thoſe particles of the blood, therefore, which have the opportunity of attracting the æthereal acid, will *give out* a portion of *phlogiſton*, which, being attracted by the *antacid*

particles in the *air*, or by the adjoining particles in the blood if the former be abſent, thoſe ant-acid particles will, alſo, *combine* with a *portion* of the *æthereal air*, which will be partly *decompoſed* and conſtitute *water*, or *fixed* air, according to the circumſtances of the antacid principle, to which the phlogiſton of the blood was tranſferred, when the æthereal acid was received into it.

By the *antacid* principle in the air and in the blood, I mean that principle which by the modern anti-phlogiſtians is called azote, as well as that of hydrogen.—Azote, hydrogen, and carbon, are, to a certainty, the *ſame principle*, only in *different ſtates*, with reſpect to the *phlogiſtic power* arranged with them—which differences may perhaps depend upon certain portions of the acid principle in intimate combination.—The *antacid* or *alkaline principle*, therefore, I employ as a *general term*, which implies the *ſame principle*, whether it be in the ſtate of earth, alkali, carbon, azote, or hydrogen—thoſe minuter

diſtinctions may be uſeful in chemiſtry, but in my preſent ſubject are unneceſſary.

8. Venous blood will attract the pure air from the phlogiſticated air in the common atmoſphere.

Phlogiſticated air will attract the pure air again from that blood :—but what phlogiſticated air? —Not the phlogiſticated air left when blood attracted the pure air from it, but the phlogiſticated air produced by combuſtion.

The phlogiſticated air, then, produced by *combuſtion* is *different* from *that* left when venous blood is expoſed to common air, becauſe, it *will* attract the æthereal acid from arterial blood, which the other *will not*; otherwiſe, ſo ſoon as the blood had attracted the pure air from common air, the phlogiſticated air left would attract it again ; which it does not.

How then does it differ ?—In being deprived of the æthereal acid by the *violent action* of *heat*,

and in having *attracted* into *arrangement* a *large proportion* of the *phlogistic power*; according to the third general law, (sect. vi.) that *every* chemical *principle* in proportion as it becomes *deprived* of the contrary *principle* in *combination*, acquires *that power* to which it has an *affinity*, which it excites to *arrangement*.

The phlogisticated air, then, procured by combustion, by means of its *excess* of *phlogiston*, will decompose the florid blood; it will readily impart a *portion* of that excess of *phlogistic power* to the blood, and by that means will *recover* its *attraction* to the *æthereal acid* in the blood; which æthereal acid will be *less forcibly* held in combination by the blood, in proportion as the *slightly* excited *phlogiston* of the *air attaches* itself to the *antacid* particles of the *blood*, containing a *less* proportion of phlogistic power than the air does, and, consequently, more attractive to it.

11. The blood, then, when exposed to the influence of the air in the lungs, acquires the *æthereal acid*, and becomes *replete* with *both*

the *æthereal* and *phlogiſtic* powers; in which ſtate it is circulated to every part of the ſyſtem. It excites the functions of the brain by its powers and motion; it imparts thoſe æthereal and phlogiſtic powers to the brain and nerves; it excites the involuntary nerves expanded upon the ſurfaces of the veſſels in which it circulates; its powers are again excited by thoſe nervous powers flowing to the material particles in muſcular arrangement, by which means, thoſe particles are attracted towards each other, and conſtitute muſcular contraction; and by the diſcharge of the nervous powers along the muſcular fibres, its powers are made to combine and form fire, which diffuſing itſelf in the blood preſent, conſtitutes the heat of animal life, which is always of courſe proportionate to the degree of muſcular action in the ſyſtem.

12. That the æthereal and phlogiſtic powers of the blood are thus diſpoſed of, is evident from many conſiderations: both are equally neceſſary to ſupport the functions of the ſyſtem: both are equally required in proportion to the actions

of the ſyſtem: the blood is equally deprived of them, by paſſing to the brain, to ſupply it and the nerves with powers, as it is in paſſing to the muſcles to aſſiſt in their actions; and both diſappear in conſequence of the diſcharge of the nervous powers along the muſcular fibres, in the ſame manner as they do when they are expoſed to the excitement of the ſame powers in electric ſtates being diſcharged through the blood, which, from florid, is inſtantly changed to black; the æthereal power being expanded and excited by the electric exploſion, to combine with the phlogiſtic power, and form heat.

13. The blood is liable to conſiderable changes from various circumſtances; the *proportion* of the *two material principles* may be conſiderably *varied*, in conſequence of which its conſiſtency and properties will be changed; but as theſe conſiderations are more ſtrictly pathological than phyſiological, I ſhall not at preſent enter into them.

14. The blood, alſo, in the healthy ſtate, is

liable to a variety of changes, in confequence of its *expofure* to the immediate *influence* of the *nerves* and the *powers* which they impart to it, producing *various* fluids, with *different* properties, in the *different glands* where thofe new compounds are formed, and fecreted from the general mafs.

15. The glands differ from each other with refpect to the ftate in which the nerves are expofed to the blood; the proportion of powers which they convey with refpect to the quantity of blood in the gland; and with refpect to the proportion which the æthereal and phlogiftic nerves, diftributed to different glands, bear to each other.

16. The fecretions of the fame gland may *vary* at different times, and in different circumftances, on account of the *different ftates* of the *blood*, with refpect to its material principles and its powers, and their relative proportions; on account of the different proportions of the æthereal and phlogiftic powers in the *brain* and

nerves; and on account of the degree of *ſtimulus* applied to the extremities of the glandular nerves themſelves; to take no notice of the various cauſes which may ariſe from morbid ſtates of the glands, or of contiguous, or connected parts.

17. That the æthereal and phlogiſtic powers may exiſt in the brain and nerves in *different proportions*, is very evident, from obſerving the effects of a large doſe of *opium*, which is of a highly phlogiſtic nature; it excites the *animating principle* of the *phlogiſtic nerves*, and, at the ſame time, it *diminiſhes* the *excitement* of the vital *æthereal nerves*:—it *fills* the brain, the nerves, and even the blood, with its *phlogiſtic* power, and it exhauſts the nerves, the brain, and blood, of their *æthereal* power, in a *great degree*, by *combining* with it: it *diffuſes* itſelf by the phlogiſtic nerves to every part of the ſyſtem: it requires *large* ſupplies of *pure air* to diſcharge it from the nerves, by exciting their reſpective actions: the *ſecretions* of the glands become *changed* by the *exceſs* of *phlogiſtic power* flowing

off from the phlogiſtic nerves of the *glands*; nay, even the diſcharges from *ulcers*, which were before the taking of the opium, *thin* and *acrimonious*, are rendered *mild*, *thick*, and *purulent*.

18. With reſpect to the blood, we may then draw the following general concluſions:

1ſt. That it conſiſts of the antacid principle, with a large proportion of phlogiſtic power; rendered ſufficiently firm and conſiſtent by the intervening attraction of a ſmall proportion of the acid principle.

2d. That the blood thus compoſed *chiefly* of the *phlogiſticated principle*, has a power of attracting the æthereal air, when expoſed to its influence in the lungs; which æthereal acid it will attract into a ſlight degree of combination; by which it will, however, loſe a *part* of its power of attraction to the *phlogiſtic power*, which will, therefore, be *transferred* to *one portion* of the *air*, while the other portion of that air is taken into the blood.

3d. That the blood thus abounding in the phlogiſtic and æthereal powers is conveyed to every part of the ſyſtem. To the brain and nerves it imparts its powers: the vital and animating principles of the involuntary nerves it excites to give motion to the heart, lungs, ſtomach, bowels, and, in ſhort, to all the arterial and venous extremities in the body; and the actions of the voluntary muſcles themſelves, it ſupports, by means of its powers, which the nerves of thoſe muſcles excite to form the attractive *media*, which draw the particles of matter in muſcular arrangement towards each other.

4th. That the blood immediately acts upon the ſimple extremities of the æthereal and phlogiſtic nerves, ſingly, terminating in the glands of different kinds; and, conſequently,

5th. That as the proportion between the æthereal and phlogiſtic powers in the blood varies, the excitement which the blood gives to the glandular nerves muſt vary alſo; and, therefore,

6th. That as the proportions between the æthereal and phlogiſtic powers in the blood, or in the nerves ſupplied from the blood, or in both, differ, at different times, and in different circumſtances, ſo muſt the ſecretions effected by thoſe glands differ in conſiſtency, activity, and in their qualities or chemical properties.

To enter more fully upon the ſubject of glandular ſecretions is, at this time, not neceſſary; neither ſhall I now ſtop to conſider the abſorbent ſyſtem, any further than juſt to ſay, that the operations of the *abſorbents* are chiefly dependent upon the muſcular fibres in their compoſition, and that their actions are excited in the ſame manner, or upon the ſame principles, as the vaſcular actions in general; that is, by means of the blood contained in their component veſſels and by the fluids they convey, conjointly exciting the involuntary nerves ſupplying thoſe muſcular fibres to throw them into action: in ſhort, the abſorbents in general are actuated by the ſame means as the *exhalents*, and they again are excited to action by the very powers which pro-

duce the vaſcular actions of the blood veſſels, with whoſe extremities they are intimately connected, if exhalation is not performed by the extremities themſelves.

SECTION XIV.

On the intellectual operations of the brain; and on the nerves distributed to the organs of sensation.

1. BY intellectual operations, I mean the various degrees and kinds of excitement of the intellectual powers of the brain, by which it perceives impressions upon the nerves of sensation, actually existing as sensations; by which it recollects former impressions, as ideas; by which it compares sensations or ideas with each other; by which it reasons and determines; and by which it executes its determinations, by transmitting power to the muscles, whose actions are subservient to those volitions.

2. The intellectual powers alone are capable of feeling, reasoning, and determining; and they alone are conscious of their existence, and

of the various kinds of excitement communicated to them.

3. The intellectual powers are not constantly excited, as is evident in sleep. They, therefore, do *not* depend upon any *one* simple principle or power, in connexion with the brain; because, if they did, so long as that connexion existed, and the brain remained unchanged, the intellectual operations would *continue* uninterrupted.

4. The intellectual powers, then, only act when they are sufficiently excited; and they are particularly excited to action by impressions made upon the nerves of sensation, and communicated by those nerves to the brain.

5. The intellectual operations, then, are excited by sensations communicated by the nerves; and when once excited, they proceed in attending to those sensations; to the ideas excited by them; and to think, reason, and act, as cir-

cumſtances excite, or former experience influences.

6. But all theſe intellectual operations of recollection, reaſoning, and determining, depend upon *prior* impreſſions: no man can reaſon, without comparing ideas; ideas cannot be compared, without recollecting them; and recollection is merely a *revival* of *former impreſſions*;—conſequently, then, *all* the *operations* of the *mind* depend upon *ſimple impreſſions*; and thoſe were imparted originally from the *nerves* of *ſenſation.*

7. *Senſations*, then, are ſimple impreſſions made upon the nerves, diſtributed to the organs of ſenſe, by ſuch ſubſtances as are capable of exciting thoſe nerves, in their peculiar ſtates of organic arrangement and connexion with matter; which ſenſations are communicated to the *common ſenſorium* by thoſe nerves.

8. As all the nerves of ſenſation are derived from the ſame common ſource, and are ſimilar

in ſubſtance, ſtructure, and in the faculty of conveying impreſſions to the ſenſorium commune, and only differ from each other in the manner in which they are diſtributed, and *combined* with *matter* in the different organs to which they are extended, it is reaſonable to ſuppoſe, that the *kind* of *excitement* which is given to them depends upon this *peculiar organic arrangement* and *combination* with *matter*.

9. It is reaſonable, then, to conclude, that the peculiar kinds of excitement of the nerves of ſenſation depend entirely upon the peculiar *ſtates* of thoſe nerves in the *organs of ſenſe*; and that whatever be the kind of excitement given to the powers, or animating principle of the nerves, thus peculiarly connected and arranged with matter, *that excitement* is accompanied with a *peculiar ſenſation*, which is communicated to the *brain*; and, conſequently, as the nerves are *differently* diſtributed and connected with matter in the different organs of ſenſe, they muſt be peculiarly liable to be excited by different kinds of matter; their *excitements* muſt be eſſentially

different; and the ſenſations excited in the brain by impreſſions upon one organ of ſenſe, muſt be eſſentially different from all other ſenſations from other nerves.

10. The *powers*, then, whoſe action conſtitutes *intelligence*, ſeem to be extended along the nerves of ſenſation to the organs of ſenſe themſelves; and the peculiar *excitements* communicated to thoſe intellectual powers, being *variouſly modulated* by the matter organically combined with them, excite *various ſenſations*, which are communicated to the ſenſorium commune; and this peculiar excitement *terminates* at the *origin* of the nerve excited in the ſenſorium commune, where it produces a certain *ſenſation*, or *perception*.

11. When that ſenſation *ceaſes*, by the removal of the exciting cauſe, ſtill the mind or intellectual powers, in action, have the faculty of *reviving* that kind of excitement in the ſenſorium commune, when it forms an *idea*, or *recollection* of a former ſenſation: but this power

of recollection, this idea, this revival of a former ſenſation, depends upon the *preſent* excitement of the intellectual powers having ſome reference to, or connexion with, the nerve which communicated that ſenſation originally: conſequently, it appears probable, that when a peculiar nerve is excited to a *certain kind* of ſenſation, the *animating power* of that nerve has a *tendency* to *repeat,* or *revive* the various degrees of excitement to which it *has been* accuſtomed; which repetition of excitements conſtitutes a revival of *ideas,* or *recollection* of former impreſſions.

12. When the animating principle of a nerve, at its origin in the ſenſorium commune, has been *repeatedly excited* in a certain manner, whenever that nerve is excited to ſenſation, it will have a tendency to aſſume *that peculiar degree,* or *ſtate* of *excitement,* to which it has been moſt accuſtomed, which will, therefore, preſent the *idea* which *correſponds* to that accuſtomed ſenſation.

13. In ſhort, whenever the intellectual prin-

ciples or powers of the brain are excited, it is by the action of the exciting cause *in motion* imparting excitement to the *animating powers* of the *nerves*; which excitement is productive of *motion*; and the excitement and motion, *together*, are communicated to the sensorium commune of the brain.—And, as the intellectual powers of the brain are sometimes *quiescent*, and only possess intelligence when *excited* to *action*, it is highly probable, that *excitement* and *motion* in the *nerves* are *simultaneous* and *inseparable*: that when excitement is communicated to the sensorium of the brain, motion invariably accompanies it, as being essential to excitement; and, consequently, that the *intellectual powers* of the *brain only exist* when in a state of *excitation*; and when excited, that they are in constant *action* or *motion*.

14. In fact, it appears evident to any common observer, if he will but for a moment stop to consider:—an impression made upon a *distant* nervous extremity, may communicate a sensation to the *brain*; which may excite *various*

ideas; which again may terminate in *volition*, by which certain muſcles are thrown into *action*.— It is evident, then, in ſuch a caſe, that the impreſſion upon the nerve of ſenſation produces *motion*, as well as *peculiar excitement* in the nervous extremity; *that* active excitement is rapidly conveyed to the *brain*, becauſe the intellectual powers of the brain are *excited* ſo as to *recall* various *preceding* impreſſions in the ſtate of *ideas*, which were communicated by *different* nerves, and, conſequently, to *diſtant* parts of the ſenſorium commune; after this intellectual action, the excitement is imparted to a ſtill *different nerve*, along which it flows with rapid *motion*, till it terminates in *muſcular contraction*.

15. It appears reaſonable, then, to ſuppoſe, as *motion* excites the intellectual powers to action, as that action in the brain may be communicated to this, that, and the other nerve of motion, and as that action may be excited by motion imparted to very different nerves, that the *intellectual powers*, themſelves, when *excited* to action, are alſo excited to *motion*; that the intel-

lectual action in the *sensorium commune* is *progressive*, from one nerve to another; that *every* nerve both of sense and voluntary action, has its *distinct origin* in the sensorium commune; and, that the excitement communicated to the intellectual powers by one nerve, may be propagated to *any* nerve, or nerves, simultaneously, or in succession, whether nerves of sensation or volition.

16. A sensation, then, is a certain excitement communicated to a nerve, which is modified by the state of the nerve itself, in the organ of sense, and by the state or qualities of the stimulus or exciting cause acting on the nerve. Every different organization of the nerve, when exposed to the action of stimuli, will produce a different degree or kind of excitement; and what is capable of exciting one nerve, may not be in the least adapted to excite another, differently exposed and combined with the principles of the organ, or part.

Whatever be the excitement given to the

nerve, it is communicated to the brain; and every different excitement muſt produce a different ſenſation, or *perceptive motion* of the intellectual powers.

17. An idea is a kind of *revival* of the *perceptive motion* of the intellectual powers, which has formerly been excited by a nerve; and when two or more ſenſations, or ideas, have been frequently excited *together*, or in conſtant *ſucceſſion*, whenever one of thoſe ſenſations or ideas is excited, the other ideas are perceived to ariſe in the mind, in regular order, in conſequence; and if a certain idea or ſenſation has frequently been excited in the brain, and as conſtantly has terminated in the *exertion* of a *certain muſcle*, or *muſcles*, whenever that idea is again excited, the intellectual actions will impart a flow of powers to that *nerve* of *motion*, unleſs other ſenſations, or ideas occur, to prevent it.

18. It appears evident, then, that the intellectual powers are excitable by matter, producing motion in thoſe powers; and that *that* motion may

be propagated to any or every nerve originating in the ſenſorium commune; and from thence to any or every voluntary muſcular fibre in the body.

The powers of other bodies act upon the powers of the nerves of ſenſe; they act upon the intellectual powers; and thoſe again upon the muſcles:—but, the nerves certainly act by means of the *æthereal* and *phlogiſtic powers*; when thoſe powers of the nerves are excited to act on the brain, the intellectual powers are excited; and intellectual excitement ſent to the muſcles is ſtill a flow of the æthereal and phlogiſtic powers.

19. It appears highly probable, then, that the *intellectual* powers of the brain are entirely *dependent* upon the *æthereal* and *phlogiſtic* powers *there*; and that probability is rendered certain by the fact, that the intellectual operations immediately *ceaſe*, if the brain be *deprived* of either the *æthereal* or *phlogiſtic* power, or *both*; as is too well known to need further attention.

20. We know that a ſtrong exertion of the intellectual powers will, if long continued, induce great fatigue, and exhauſt the æthereal and phlogiſtic powers of the brain: we know that in ſuch a ſtate of exhauſtion *ſleep* will reſtore thoſe powers to the brain, if æthereal air and proper nouriſhment are not deficient:—it is evident, then, that the *intellectual* operations themſelves require both the *æthereal* and *phlogiſtic* powers; and that thoſe powers are *conſumed* by intellectual action, but *accumulate* in ſleep.

21. The ſenſorium commune, then, muſt be connected with *thoſe parts* of both the cerebrum and cerebellum, which are particularly formed for the purpoſe of *ſeparating* the æthereal and phlogiſtic powers from the blood:—the *æthereal* power then is conveyed to the ſenſorium commune by *one* ſet of nerves or medullary fibres; the *phlogiſtic* power by *another*.

22. We have, on many occaſions, obſerved, that the powers of a nerve of volition are *qui-*

eſcent, till the *vital* principle is *excited*; and, conſequently, then, it is reaſonable to ſuppoſe, that the powers flowing by their reſpective nervous or medullary conveyances to the ſenſorium commune, may ſtill *remain* and *accumulate* there, if the ſenſorium be *not* excited.

23. *Sleep*, then, ſeems to be that ſtate of the ſenſorium in which there is no *ſufficient excitement*, capable of producing a full *flow* of the æthereal and phlogiſtic *powers* from their diſtinct *ſources*, (21) into the *ſenſorium*. A ſlight excitement may produce a partial flow of the two powers, with imperfect and ill-connected ideas, as we find occaſionally, and which we call *dreaming*, but the *full* exertion of the intellectual powers requires the *free flow* of the æthereal and phlogiſtic powers from their reſpective ſources; by which means, the ſenſorium is *replete* with the *two powers*, and every excitement communicated by the nerves of ſenſation is perceptible.

24. The intellectual principles, then, are peculiarly reſident in the ſenſorium commune:

they are excited to attention and perception by impreſſions on the nerves of ſenſation, being communicated to the ſenſorium: that excitement when in a ſufficient degree is communicated to the animating principles of the *medullary fibres* which *ſupply* the *ſenſorium* with the *æthereal* and *phlogiſtic powers*:—thoſe contrary powers then *flow* to the ſenſorium, in proportion to the *excitement there*; by which means the ſenſorium is not only excited, but it can *act* with *energy*, till that ſupply of powers is *exhauſted*; by the intellectual operations *combining* them *together* in the brain, or *tranſmitting* them to the nerves of *motion*.

. . . .

25. The intellectual principles, then, *cannot* act without the two powers derived from the blood; and thoſe powers are *quieſcent*, unleſs the *intellectual* principles be *excited* to put them in *motion*.

. . . .

Intellectual operations, then, are produced by the *conjoint* influence of the *intellectual principles* and the *æthereal* and *phlogiſtic* powers; by

thofe operations the powers are combined and converted into *fire* or *heat*; and by that change of ftate the fenforium becomes gradually *exhaufted* of thofe powers, in their ftate of feparation, neceffary to produce intellectual action; in confequence of which, intellectual excitement naturally *ceafes,* for *want* of powers; and when the excitement in the fenforium ceafes, the *powers* no longer *flow* into it, but gradually *accumulate* in their refpective fibres, till they again, by the fecretions of their refpective *fources,* become fo abundant as to be ready to flow into the fenforium, in confequence of excitement being tranfmitted by the nerves, or of their own accumulation.

26, It is not the brain *alone* which acquires a ftore of powers by quiefcence, the nerves of fenfation and voluntary motion alfo, acquire them by fecretion, or feparation from the blood, circulating in their external coverings; in confequence of which, they alfo become *more excitable* by means of *fleep,* and impart impreffions with redoubled energy: thofe impreffions or

excitements being tranſmitted to the *ſenſorium*, will be readily conveyed to the *ſources* of its *powers*, and thoſe *powers* will *flow* into the *ſenſorium* in conſequence; by which the *intellectual operations* will become generally *excited*, and all the powers of the mind in readineſs to *act*, as circumſtances may require.

27. When the ſenſorium is thus ſupplied with powers, and the intellectual principles are excited to act with thoſe powers, every peculiar excitement imparted by the nerves of ſenſe is perceptible, with a ſenſation, correſpondent to the ſtate and degree of excitement; and whatever *part* of the ſenſorium is excited, *it* has a natural tendency to *repeat*, or paſs into *thoſe ſtates* of excitement to which it has been *accuſtomed*, if the ſenſorial attention be not excited to a different part; in conſequence of which, *previous* ſenſations may again be revived, under the form of *ideas*;—two or more ſenſations, or ideas, may alſo ſo frequently recur together, or follow one another, that whenever *one* is excited the *other* is revived alſo; and two ſimultaneous ideas may ſo

frequently occur, and ſo conſtantly produce a *third*, that, whenever thoſe two again are revived in the ſenſorium, the *third* is alſo revived as a natural conſequent.

28. In fact, one grand property of the intellectual principles, when excited to action, is, that *previous ſenſations* are *revived* and *perceived* as *ideas*; a ſucceſſion of ſenſations may be revived and perceived as a chain of ideas; two or more perceptions being conſtantly and repeatedly followed by a third, will be revived as cauſe and effect; in ſhort, upon this peculiar property of *repetition* of *ſenſorial actions*, or *revivifications* of *ſenſations* as *ideas*, ſingly, or in aſſociation, *all* the functions of the intellectual powers, which we call mind, depend.

29. It is not my intention to enter minutely upon a ſubject ſo intricate, ſo extenſive, ſo complicated, and important, at preſent; that I ſhall reſerve for my amuſement at a future period, and ſhall only, at this time, make a few obſer-

vations on ſenſations, and then diſmiſs the ſubject.

30. The nerves diſtributed to the organs of ſenſe are formed of the ſame materials as the other nerves; that is, they conſiſt of fibres conveying the *æthereal* and other fibres tranſmitting the *phlogiſtic power.*

31. In the organs of ſenſe theſe diſtinct fibres, I ſuppoſe, are expoſed *together,* ſo as to be *each* and *ſingly,* ſubject to *impreſſions* from ſuch ſubſtances or powers as are capable of acting upon them, through the *material coverings* with which they are always defended.

32. Whatever, then, is capable of acting upon either the æthereal or phlogiſtic nerve, ſo as to *excite* it, is capable of producing a *ſenſation* in the ſenſorium, by the tranſmiſſion of that excitement by the nerve to the brain.

33. If the *æthereal power* of the nerve be

excited, it is natural to ſuppoſe that it will be perceived in the ſenſorium with a *different ſenſation* than if the *phlogiſtic* nerve were excited: and if *both* be excited at the ſame time, the ſenſation perceived in the ſenſorium muſt be ſtill *different* from *either*.

34. But either of the powers we know are capable of *various degrees* of excitement; conſequently, if *either* of them be *ſingly* excited, ſtill the degree or kind of that excitement may be *various*, in different circumſtances; and, conſequently, will excite *various ſenſations* in the ſenſorium, or at leaſt ſenſations *differing* in *degree* or *intenſity*.

35. *Light* is the æthereal and phlogiſtic powers univerſally diffuſed, *excited* in a certain degree, which excitement is *rapidly propagated*: in that ſtate, thoſe powers are of *no colour*, that is, they ſimply excite the ſenſation of *light*, but *not* of *colour*.—If that excitement be propagated through the *atmoſphere* ſurrounding a body, varying in *extent* and *degree* of *excitement*, in conſe-

quence of the form of the body, and if *that* atmoſphere has a peculiar attraction to *one power*, *that* power will be attracted towards the *ſurface* of the body, *particularly*; while the *other* is *not* attracted by the body or its atmoſphere, and would proceed in a right line, were it not *drawn aſide, in part*, by the *attracted power.*

The powers conſtituting the light are then *ſeparated*; the æthereal power proceeds in *one* direction, the phlogiſton in *another*; ſtill, however, they are attractive to each other, and form a *coloured ſpectrum*, from which the æthereal and phlogiſtic powers are reflected to the eye, and produce the ſenſations of *various colours* flowing into each other.—The centre of this ſpectrum is *green*, and is evidently formed of the *two powers*, more or leſs perfectly excited and *connected*; while the *medium colour* of *one* end of the ſpectrum is *orange*, and of the *other purple*, or *indigo* as Sir Iſaac Newton termed it.—The warm *orange*, glowing into *ſcarlet*, or attenuated into *yellow*, is ſtill the *ſame power* more or

leſs perfectly *excited* and *freed* from the influence of the other power; and the cold *indigo*, or *purple*, deepens into *violet*, or brightens into *blue*, as the principle is more or leſs excited and diſengaged, and is evidently excited by the *contrary power*, to *that* which excites the orange and warm colours.

36. All the ſenſations of *colour*, then, I ſuppoſe, are excited by the *æthereal* and *phlogiſtic powers*, in lucific excitement, being more or leſs perfectly *ſeparated* and *modified* in their *excitements*, by the powers commonly excited and *arranged* around *material bodies*; in which ſtates, paſſing to the expanſions of the *optic nerves*, they excite the æthereal or phlogiſtic fibres of thoſe nerves, or both, in correſpondent degrees; which excitements being tranſmitted to the ſenſorium, are perceived as ſenſations of *colours*, varying with the excitement and the exciting cauſe.

37. In a ſimilar manner, I conceive, all the ſenſations of the different organs of ſenſe, ex-

citable by the *powers* of ſubſtances, are to be explained.

It is not ſimply the atmoſpheric *air* which excites the various modulations of *tone*, which enchant the ſoul with their melodious flow, or harmonious concord, by acting upon the *auditory nerves*, which, like all others, are both æthereal and phlogiſtic,—it is the *æthereal* and *phlogiſtic powers* in general diffuſion around, which are capable of all the *various excitements* with reſpect to *tone*, that they are with reſpect to *colour*. The muſical *ſcale* exactly correſponds with the *ſpectrum* of priſmatic colours: — the three lower tones are excited by one power; the fourth, or middle tone, by the two powers; the three higher by the contrary power to the firſt: the different *velocities* of *vibration* in ſonorific bodies, excite the *one* or the *other power*, or *both*, and excite them *alſo* in *different degrees*; and the ſenſations of harmony and diſcord in ſounds, reſemble the harmony or contraſt of colours, in all reſpects, except in the actual ſenſations and the modes in which they are excited.

The nerves of *taſte* and *ſmell* are each formed, alſo, of fibrillæ conveying the æthereal and phlogiſtic powers, diſtinctly; and the different ſenſations of taſte and odour are produced by the æthereal or phlogiſtic powers, in different proportions and ſtates of *evolution* in the various ſubſtances which are taken into the mouth or the noſtrils, acting *together*, or *ſingly*, in *various ſtates* of combination, ſeparation, and excitement.

38. *All* the organs of *ſenſe*, then, I ſuppoſe, are ſupplied with nerves, conveying the *æthereal* and *phlogiſtic powers*, but *ſingly*; and thoſe nerves are ſubject to excitement from the æthereal and phlogiſtic powers ſingly, or ſeparately excited in various degrees by different ſubſtances and means; *each* power producing a *diſtinct* ſenſation, correſpondent to its ſtate and degree of excitement.

The ſenſe of *feeling*, however, may be an exception; as it ſeems to depend upon *material*

impreſſions, and not upon the *powers* excited by matter.

39. From what has already been advanced in explanation of the various functions of the living body, it appears to me evident, inconteſtably ſo, that there are *two powers* eſſentially neceſſary to produce thoſe operations; and that *each* power is conveyed by its *diſtinct nervous fibrillæ*:—it is likewiſe evident, that neither matter, nor the powers which actuate it, are *capable* of either ſenſation or thought; conſequently, there muſt be a *living principle* or *principles*, which can *feel* and *think*—which are *diſtinct* from both matter and power.

40. But we know that the *powers* in *motion*, can excite the principles of *life* or *animation*, as is evident in electricity: we know that the *powers* can excite *ſenſation*, as is evident when *light* excites the ſenſation of *colour*: and we alſo know that the principle of *life* or *animation*, can impart motion and excitement to *power*, as is evident when a *volition* in the brain cauſes a flow of the

powers along a *nerve* to throw a *diſtant muſcle* into *action.*

41. Is it then *one* homogeneous, vital principle, which *animates* the *whole ſyſtem*, or has *each power* its ſpecific *principle* of life, or animation ?

42. Either of the powers or nerves may be excited to ſenſation, or to tranſmit its excitement to the ſenſorium ; but it depends upon the *ſtate* of the *ſenſorium*, whether that excitement is *perceived* there or *not* : but, the nerve excited certainly does poſſeſs a living power ; ſo does the ſenſorium, and the one ariſes from the other.— It appears, then, that the excitement of the nerve, its power, and living principle, neither ſleeping nor waking, is really *perceived* in the *ſenſorium*, unleſs the *ſenſorial principle* be directly *attentive* to that excitement ; and the ſenſorial principle *itſelf* is *without perception*, when *not excited* by the powers or principles of the nerves, or the ideas connected with or ariſing from them : conſequently, it is allowable to ſuppoſe, that the

intellectual operations of the *ſenſorium,* depend upon *two principles,* which, acting *together,* produce *perception,* and which having the property of *reſuming,* or *paſſing through* the various modes and ſtates of action which they have been *accuſtomed to,* conſtitute, or produce thoſe various intellectual operations, which we call recollection, compariſon, reaſon, judgment, and determination.

43. If this be admitted, then, we may conclude, that *each kind* of nerve has its *diſtinct principle* of life, or animation: and by way of diſcrimination we may call the *principle* which actuates the nerves conveying the *æthereal power,* the *vital principle*; and *that* which actuates the nerves tranſmitting the *phlogiſtic power,* the *animating principle.*

44. Either of theſe *principles* is capable of being excited by its reſpective power in motion, and of communicating that excitement to the ſenſorium, where ſenſation is *perceived* if the *contrary principle* of the *ſenſorium* be preſent to *act*

with it: and either of them may, by excitement in the ſenſorium, tranſmit its power to the muſcles. But, *perception* and all the *conſequent operations* of the ſenſorium, only ariſe when the *vital* and *animating principles* are *excited* to *act together*, and have ſupplies of the *æthereal* and *phlogiſtic powers*, upon which their excitement and power of action depend; and as neither the æthereal nor phlogiſtic power can act alone, nor the vital nor animating principles can ſingly be excited to conſciouſneſs and thought, it is probable that the *medullary fibres* of the ſenſorium commune with their *powers* and *intellectual principles*, are ſo diſpoſed and conſtructed that the *æthereal* origins of the *nerves* of ſenſation and motion with their *vital principle*, ſhall *correſpond* to the *phlogiſtic* medullary fibres of the *ſenſorium* with their *animating principle*; and that the *æthereal* power and *vital* principle of the *ſenſorium* ſhall correſpond with the *phlogiſtic* origins of the *nerves* of ſenſe and volition with their *animating* principle; by which means, when either the ſenſorium or nerves are excited, the *contrary principle* at the point of contact, or where the *nerves originate*, is

ready to act and perceive, if the senforium be in a state of excitement or *attention*, by the presence of the æthereal and phlogistic powers being excited to flow from their sources in the cerebrum and cerebellum, to the senforium.

45. Perception and thought require the *co-action* of the vital and animating principles: their action requires *excitement* as well as powers; for excitement is only produced by the co-action of the *powers* with their respective *vital* or *animating principles*: when the intellectual operations are excited in any particular part of the senforium, the *powers* of the senforium are particularly directed to flow to *that excited part*; and when the intellectual principles are *destitute* of excitement, or *exhausted* of powers, they become *quiescent*: the powers are no longer excited to flow to the senforium from their respective sources in the cerebrum and cerebellum, and *sleep*, or a suspension of the intellectual action, takes place.

46. Were these conjectures admitted, it

would follow, that perception and thinking, reaſoning, judging, &c. reſemble attraction; and the *principles* producing them have a ſimilitude to the *powers* which produce attraction; for the *æthereal* power may be excited to *arrangement* around matter, and yet be *inactive*; ſo may the *phlogiſtic* power; and it is only when they come into *contact* in *ſimilar ſtates* of atmoſpheric excitement, that they *attract each other*, and draw their reſpective material centres into contact;—ſo alſo the *vital* and *animating principles* of the nerves and ſenſorium may either of them be excited, with its reſpective power, and yet neither of them, *ſingly*, can produce either ſenſation, thought, or conſciouſneſs; but, when they act *together*, that action is *perception*, *thought*, or *conſciouſneſs*, and the powers they are reſpectively connected with are brought into combination, and aſſume a new ſtate, that of fire, or heat when diffuſed into the parts around; or thoſe powers may be tranſmitted to muſcular fibres, and cauſe them to contract before they combine and conſtitute heat by flowing into the

blood of the muſcle which they have made to contract.

This is a ſubject, however, of too intricate a nature to be treated thus extemporaneouſly ; I, therefore, ſhall here cloſe my inveſtigations for the preſent, and terminate my inquiries with a few general obſervations on the effects of poi-ſons, and on the influence of different metals when applied to the nerves of animals while they retain their living powers.

SECTION XV.

On the effects produced on living animals, by means of animal and vegetable poisons; and in consequence of cutting certain nerves connecting peculiar parts of the body with the brain.

1. IT is not my intention to enter into a minute discussion of the numerous experiments with animal or vegetable poisons, which have been made by the Abbé Fontana, Dr. Monro, &c.; neither do I intend to consider all the experiments which have been published by Mr. Cruikshank and others, on the effects arising in consequence of cutting various nerves in the living animal; I mean only, to take a general view of the more important effects which have arisen from them, and to give such explanations as the principles of my theory offer, and leave it to others to judge how far those explanations are more or less satisfactory and consistent,

than the explanations which have hitherto been given, and commonly received.

2. As the Abbé Fontana has made the moſt numerous ſacrifices of his feelings for the purpoſe of attaining knowledge, of any man with whom I am acquainted, I ſhall begin with his experiments firſt; not that I think the man who can look with an eye of indifference upon the agonizing tortures of animals, whoſe feelings are as acute as his own, is the more eſtimable on that account; but, becauſe thoſe modes of torture are more varied, and the effects the more numerous and diverſified.

3. I by no means, however, think it blameable to try certain experiments, deviſed by cool deliberation, the reſults of which may be productive of general good; but, I muſt confeſs that *I think* thouſands of the poor animals which were tormented and deſtroyed by the Abbé Fontana, were ſacrificed in vain! Neither can I think it by any means juſtifiable, for a man to wantonly repeat the ſame cruelties again and

again, to ſatisfy the idle curioſity of men who are not *likely* to improve the art of removing the diſeaſes of mankind, as is practiſed by ſome at preſent. In the hands of a Monro, of a Bailie, a Cruikſhank, or any profeſſor of anatomy, ſuch experiments may be acts of mercy to the animal creation; becauſe, being dextrouſly performed before numbers, they may ſatisfy their curioſity, and afford them facts for reaſoning upon, without every individual being left under the neceſſity of performing them to ſatisfy himſelf; conſequently, one experiment performed before hundreds, may prevent that experiment from being repeated hundreds of times; that is, by each individual.

4. Can I read of a dog being confined without food for thirty days, merely to know how long that poor animal would be in ſtarving to death—without horror?—Can I ſee, in idea, the cruel author of his unneceſſary ſufferings, approach him in his latter moments, and ſee him while he has any remaining ſtrength, wag his tail, and look with affection and kindneſs

upon him, and yet leave him to his cruel fate without remorse?—I say, can I consider this, and not feel compassion, in its most poignant degree, for the harmless, suffering animal, and indignation for the author of his misery?—Surely I cannot, and I glory in my feelings!—But enough—it is not the *feelings* of mankind, but the EXPERIMENTS they have made which I have at present occasion to consider.

5. It is proved by the Abbé Fontana's experiments, that the poison of the viper mixed with the blood flowing *from* a vein, *prevents* it from *coagulating*; but, injected *into* a vein, the blood is *coagulated instantly*. This is a difficulty he could never surmount, because he resolutely denied every interference of the nerves in the effects produced by poison.

6. It is evident, however, that the coagulation *cannot* be simply effected by the *poison* acting on the *blood*, because by that simple action the blood is *deprived* of its *natural* power of coagulating: it must, therefore, to a certainty,

be produced by the co-operation of ſome *additional agent*; and what additional agency it does ariſe from, may beſt be diſcovered by attending to the other effects produced, at the time when the coagulation of the blood takes place.

7. When the poiſon of the viper or the ticunas is injected into a vein, for example, the jugular, the actions of the heart and lungs are deſtroyed, ſo as to be *incapable* of *propelling* the *blood*; and the right ſide of the heart and the lungs are found *diſtended* with *blood*, black, and coagulated.

8. The effect produced by the poiſon, then, is not ſimply the coagulation of the blood; the *vaſcular extremities*, alſo, which have been expoſed to that poiſon in the blood, have *loſt* their *excitability*; their *muſcular* action, propelling the blood, is *deſtroyed*; the *nerves* expanded upon the ſurfaces of thoſe vaſcular extremities have *loſt* their *vitality*; they are no longer *excitable* by the powers in the blood, and no longer *capable* of tranſmitting their powers to the muſcular

fibres in thoſe vaſcular extremities, by which their blood is propelled.

9. The poiſon, then, when received into the blood, is circulated with it, and deſtroys the *vitality* of the *nerves* expanded on the ſurfaces of the *blood veſſels*, particularly at their *extremities*, as it proceeds; and as the nerves thus expanded on the ſurfaces of the blood veſſels, conſtantly receive a flow of the *æthereal* and *phlogiſtic powers* from the brain, which is accumulated in thoſe expanſions, and detained there by the vitality of the nerve, till they are excited to flow to the muſcular fibres, it muſt follow, that when the poiſon deſtroys the vital power of thoſe expanſions, expoſed to the influence of the blood, the *powers* accumulated *there* by the vital principle, muſt become *diſengaged* by the deſtruction of that vitality, and *they muſt*, therefore, *flow* into the *blood*, ready to receive them. It is, therefore, by the acceſſion of the *powers* of the *nerves* that the *blood* is *coagulated*, and the more completely the vitality of the nerve is

deſtroyed, the more ſudden and perfect the coagulation of the blood.

10. When the poiſon of the viper, or ticunas, then, is thrown into the jugular vein, it inſtantly paſſes to the heart, and from thence to the lungs, where the *involuntary nerves*, expanded on the ſurfaces of the blood veſſels, are expoſed to the poiſonous influence; the *vital* principle is *deſtroyed*; the nervous powers are no longer *detained* in the nerves; they *flow* into the poiſoned *blood* and *coagulate* it; the vaſcular extremities are *no longer excited* to act; and the circulation of the blood ceaſes.

11. But this by no means accounts for the *immediate death* of an animal, in the manner effected by the injection of the poiſon; becauſe, as ſoon as the poiſon is injected, the animal becomes univerſally convulſed, and dies.

12. If an animal be prevented from breathing proper air, or air containing the æthereal acid, the blood accumulates in the right ſide of the

heart and in the lungs; the vaſcular extremities ceaſe to act, and the blood ceaſes to flow;— but, before the animal arrives to this ſtate, *violent efforts* to *inſpire* are excited, by the powers conſtantly flowing to the nerves of the lungs; *accumulating* there for want of the excitement of the æthereal air; and *regurgitating* to the nerves and muſcles of inſpiration:—but, when poiſon circulates to the lungs, and deſtroys the vitality of the nerves there, there is *no* accumulation of powers in thoſe nerves, and *no* tranſmiſſion of thoſe powers to the nerves and muſcles of inſpiration to excite them to act: conſequently, the *poiſon* which *deſtroys* the *vitality* of the nervous expanſions in the lungs, muſt, alſo, *deſtroy* the *vital principle* of the *nerve* in its *full extent*.

13. When, therefore, the poiſon is applied to the nervous expanſion in the lungs and heart, it *deſtroys* the *vitality* of the nerves in thoſe parts; that deſtruction of the vital principle *aſcends* upwards, towards the *brain*, by which the nerves of the lungs and heart are *incapacitated* from *receiving*

any *further* flow of the æthereal and phlogiſtic powers from the brain.

14. But, thoſe branches of the *par vagum* which chiefly ſupply the lungs, and partly the heart, are derived from *all* the *nerves* of *motion*, ariſing from the brain; and the powers flowing to *every* nerve from the brain, are *partly* ſent to the nerves of the lungs and heart; conſequently, then, when the vital power of the nerves of the lungs is deſtroyed, as far as the *nerves* of *motion* from which they *ariſe*, the conſtant flow of powers from *thoſe nerves* will be *prevented* from flowing *to the lungs*, and they will flow, therefore, in *unuſual* quantities to the *muſcles* in *general*, by which thoſe muſcles will be excited to *unuſual action*: but, in a moment, the deſtruction of the vital principle of the nerves is communicated to *all thoſe nerves* of motion, from which the nerves of the lungs ariſe, and alſo to the *brain* itſelf: the regular but increaſed flow of powers to thoſe nerves quickly, therefore, becomes *interrupted*: they flow in *irregular jets*, producing convulſive motions in the muſcles:—ſoon, however, the

poiſon deſtroys the vital principle of the *brain* and *nerves*, and *death enſues*.

15. If the poiſon of the viper, of the ticunas, of opium, or of the lauro-ceraſſus, whoſe deleterious powers are the moſt evolved, be taken into the ſtomach, convulſions and death almoſt inſtantly enſue. This ſudden deſtruction of the vital principle of the brain and nerves, *cannot* be owing to the *poiſon* acting upon the ſyſtem by means of the *blood*; becauſe, admitting that the poiſon is taken into the blood, in the ſtomach, it can only, inſtantly, deſtroy the vaſcular actions *there*, but *cannot* be *tranſmitted* to the *heart* and *lungs*, without *firſt* of all being collected in the *vena portæ*, and circulating through the *liver*; which requires a length of time, by *no means* compatible with the *ſudden* deſtruction produced by the poiſon.

16. But, the ſtagnation of the blood in the ſtomach, *cannot* cauſe ſo ſudden a deſtruction of the vital principle of the brain and nerves:—the poiſon, then, *muſt act* upon the *nerves* of the

ſtomach, by deſtroying the vitality; and that *extinction* of the *vital principle* muſt *proceed* along the *nerves* towards the brain.

17. The ſtomach is chiefly ſupplied with nerves from the par vagum; and thoſe nerves like thoſe of the lungs, ariſe from *all* the *nerves* of motion proceeding from the brain; conſequently, if the vital principle of the *nerves* of the *ſtomach* be deſtroyed by the poiſon, that deleterious influence will be communicated to *all* the *nerves* ariſing from the brain; and till that deſtruction of the vitality of the nerves is actually *communicated* to the *reſt* of the *nerves* and the brain, the conſtant flow of powers from thoſe nerves into the *nerves* of the *ſtomach*, will be *gradually prevented*, as the deſtructive influence aſcends; and, conſequently, *thoſe powers* will flow in *increaſed* proportions to the *other nerves*, and produce thoſe *convulſive* motions of the *muſcles*, which ſo generally ariſe when poiſons are applied to the ſtomach.

18. If a *large* proportion of poiſon, in a *very*

active ſtate, be taken into the ſtomach, or thrown into the blood, inſtant death is produced, *without any* convulſions, or muſcular actions whatever; conſequently, the *vital principle* of the *nerves* may be *totally* extinguiſhed, *without* the *powers* in the *nerve* being in the leaſt *excited* to *flow*.

19. If, then, the poiſon of the viper be applied to the *trunk* of a nerve, the ſciatic nerve, for example, ſo generally choſen for experiment by the Abbé Fontana, it may ſo *inſtantly* deſtroy the vitality of that nerve, as to *prevent* it from imparting *any motion* to its *powers*; conſequently, as the coagulation of the blood is only effected when the *poiſon* and the *powers* of the nerves are *together* imparted to the blood, it was in vain for the Abbé to look for the *coagulation* in the *blood* of the muſcles to which that nerve was diſtributed. The poiſon could merely act upon the *vital principle* of the nerve; that might be extinguiſhed *without any flow* of the powers being excited; and, conſequently, the blood could *not* be coagulated, becauſe the coagulation de-

pends upon the *powers disengaged* from the *nerves* as well as upon the poison.

20. If the poison, then, be applied to the trunk of the sciatic nerve, and simply destroys its vitality, that destructive influence will be communicated to the brain ;—to *one single portion* of the brain, from which the sciatic nerve arises; for the sciatic nerve is not like the par vagum which is connected with *all* the nerves arising from the brain ; it is simply a *nerve*, extending from the brain to the *muscles* :—the *small portion* of poisonous influence communicated to the nerve may destroy the vitality of *that nerve*, without being *sufficient* to derange, or destroy the vitality of the *brain* ; and, that that *is* the case, is evident, from those who having been bitten by a viper, have become *paralytic* with considerable *diminution* of the powers of the *brain*.

21. That poisons may act upon the nerves when applied to their *trunks*, is proved to a certainty, by the Abbé Fontana himself; because, upon applying a spirituous solution of opium to

the crural nerves of frogs, the mufcles in which thofe nerves terminated were deprived of motion: fpirit of wine produced the fame effect; a folution of opium in water did not fo evidently: —what then? fpirit of wine, at leaft, is capable of deftroying the vital powers of the nerves; and fpirit of wine is a poifon, whofe general effects are fimilar to thofe of opium itfelf; only, the deleterious powers are more evolved in *one* than in *the other*.

22. Since fpirit of wine, then, is a poifon which deftroys animals when taken into the ftomach, and when injected into the blood, as the poifons of the viper, the ticunas, the lauro-ceraffus, and opium do; and fince it evidently does deftroy the vital principle of the *nerves* by application to them, inftead of concluding, fo directly contrary to experiments, that poifons are *innocent* when applied to the *nerves*, he ought to have concluded, that certain poifons, when mixed with the blood, or with the gaftric fluids, may be capable of acting upon the nerves expofed to their conjoint influence, which poifons,

when their powers are *not evolved* by the blood or gaſtric fluids, may be *incapable* of acting upon a nerve itſelf; ſince other poiſons, whoſe principles are in a *different* ſtate of *evolution* and *activity*, *do, certainly*, deſtroy the vitality of the nerves to which they are applied.

23. But, that the poiſon of the viper may deſtroy the vitality of the nerves, for any thing which the Abbé Fontana has ſhown to the contrary, I have already explained: and that it *does*, in *ſome caſes*, is evident from the paralyſis which follows the bite of the viper, which, though ſufficient to deſtroy the functions of a *voluntary nerve*, and even the neighbouring parts of the brain, to a certain degree, is *not* capable of deſtroying the *general vitality* of the ſyſtem, when applied to the extremities of a *nerve* of *volition*.

24. An experiment made by Dr. Monro, relating to the preſent ſubject, I ſhall now introduce:—he found that when every communication between the trunk and poſterior extremities of a frog were deſtroyed, except the *ſciatic nerves*,

by injecting a ſtrong ſolution of opium under the ſkin of the *poſterior extremities*, they were deprived of ſenſibility and motion; but, the *trunk* of the body was *not* affected.

In another experiment the Doctor found, that the ſolution of opium poured into the *heart*, produced convulſions of the *legs*, when the venæ cavæ and aorta were *previouſly cut*: and he alſo found that it affected the legs in the *ſame manner*, when poured into the cavity of the *abdomen*, *after* the heart was cut out.

25. From the firſt experiment it appears, that opium applied to the extremities of the *ſciatic nerves*, deprives *them* of their powers of ſenſe and motion; but, that effect is *not* communicated to *other nerves*; and from the other experiments it is evident, that opium applied to the *heart*, or cavity of the *abdomen*, *does* affect the nerves of *thoſe* parts; and from them the effect *is* alſo communicated to the *nerves* and muſcles of the *poſterior extremities.*

26. The ſciatic nerves ariſe from the brain ;—I do not, however, mean that they are directly *ſent off* from the brain, but, that the fibres of which they are compoſed have *diſtinct origins* in the *brain*, although they paſs along with other nerves in a maſs which we call the ſpinal marrow: ſo that the ſpinal marrow is, in fact, no other than a *general aſſemblage* of the *nerves* diſtributed *from the brain* to various parts of the body, from which they are detached, in pairs, to the parts they are deſtined to influence. That this is the caſe, appears to me not to admit of a doubt; for *volition* certainly ariſes *in* the brain, and it can tranſmit its power from the brain to *any particular* voluntary muſcle, or even to a *certain part* of ſome muſcles; which proves that the *very fibres* of a nerve, diſtributed to *any particular* muſcle, *originate* in the *brain*, which can excite its powers to flow to thoſe fibres, and *thoſe only* :—that this volition does reſide *in* the *brain*, and that the excitement or powers which are tranſmitted to the muſcle are ſent *from* the brain, is evident from this conſideration, that if the medulla ſpinalis be *cut*, *above* the part from

which *any nerve* is ſent *off*, the volition may *ſtill* remain, or be excited in the brain, but the intercourſe being deſtroyed, it *cannot* throw the muſcle, to which that nerve is diſtributed, into action.

27. The ſciatic nerves, then, ariſe from the brain—from *one ſingle portion* of the brain; and their office is to convey the powers excited by volition, from the brain to the lower extremities. If, then, opium be applied to thoſe nerves, if it deſtroys their vital principle upon which the tranſmiſſion of their powers depends, and if that extinction of the vital principle aſcends to the brain, there it muſt ſtop: at leaſt, any further effect muſt be ſmall, as it cannot be ſuppoſed that the effect of the opium applied to ſo *diſtant a part*, and to a *ſingle nerve*, can be communicated to the *brain*, with *ſufficient power* to *deſtroy all* its *vitality*, as well as that of *all* the *other nerves*; becauſe, the ſciatic nerves, ſimply ariſe from *one portion* of the brain, and have *no* connexion with other nerves, except a few branches ſent to the intercoſtals and par vagum, by which

they convey powers flowing from the brain; and even admitting that the extinction of the animating principle of the sciatic nerves, were to be communicated to those *involuntary* nerves, still, the effect could be but small; since *their* communications form but a *small portion* of those nerves, which are formed from *all* the nerves arising from the brain.

28. But, on the contrary, when the solution of opium is applied to the *heart*, or injected into the *cavity* of the *abdomen*, it acts upon the *extremities* of *all* the *nerves* of the intercostals and par vagum, distributed to those parts; and as those nerves are formed into various *plexuses*, the effect upon those branches distributed to *one part*, must be communicated to *all*: consequently, then, the deleterious effects of the opium on the heart or abdomen, will be communicated, not only to the intercostals and par vagum, but also to *all* the *nerves* of *motion* in the system, as *from them* they arise, and *with them* they are intimately connected. The extinction of the vital powers of the *involuntary* nerves, will be communicated

to *all the other nerves*, and from them to the *brain*; hence the *convulſions* and *deſtruction* of power and vitality, in conſequence, if the quantity of opium applied be ſufficiently great.

29. If this explanation be not juſt, there is no other means of ſolving the difficulty, but by allowing that there are *certain nerves* diſtributed to the lungs, heart, ſtomach, and abdominal viſcera, along with the par vagum, which have the *ſingular property* of *conveying* the æthereal or phlogiſtic powers, in certain ſtates, applied to their *extremities, directly to the brain*; while all the nerves of motion only convey the powers *from* the brain to the parts to which they are diſtributed.

30. That this may be the caſe, is by no means improbable; for we know that pure air will ſometimes reſtore the functions of the brain and nerves, when they are ſuſpended, and motion has ceaſed, by being applied to the nerves of the lungs; and that wine or ſpirits will impart inſtant vigour and energy to the brain and

nerves, when greatly exhausted, by being applied to the stomach, which must be effected either by the æthereal power in the lungs and the phlogistic power in the stomach, being *transmitted* by *certain nerves to* the brain; or otherwise, by the excitement which those powers give to the *vital* principles of *those nerves*, which *excitement* is communicated to the *brain*, as I have formerly supposed, rather than admit of a peculiarity in these nerves, which is not observed in any other; and I still must retain my former opinion, till it be found that this *peculiarity* in the nerves of the stomach, &c. *does*, in reality, exist.

31. I shall conclude this section with a few general observations and remarks on the experiments made by Mr. Cruikshank and others, on animals, by cutting the par vagum and intercostal nerves.

When the par vagum and intercostals are *both* cut, the animal is extremely affected; *respira-*

tion becomes painfully *laborious*; the lungs become *diſtended* with blood, and it dies.

In this experiment the animal lives *ſeveral hours*; but, if the ſpinal marrow be cut above the firſt vertebra of the neck, the animal dies *inſtantly*.

32. When the par vagum and intercoſtals are *all* cut, reſpiration becomes laborious; the actions of the ſtomach are diſordered; the actions of the heart are impaired; the lungs become loaded with blood; and the animal dies:—becauſe the functions of the lungs, of the heart, ſtomach, &c. depend upon a *conſtant flow* of the æthereal and phlogiſtic powers from the brain and nerves of motion, to the par vagum and intercoſtal nerves; which powers, flowing to the *expanſions* of thoſe *nerves* upon the *blood veſſels*, are excited by the blood, when duly ſupplied with phlogiſtic food and æthereal air, to flow to the *muſcular fibres* interwoven in the *vaſcular extremities* of thoſe parts, and cauſe them to *contract*, by which contraction the *blood* is *cir-*

culated :—consequently, if the flow of those powers to the lungs, heart, stomach, &c. be *cut off*, their *vascular actions* must gradually *cease*; and the *blood* must be propelled with *diminished* power and motion, as those powers in the nerves become more and more exhausted.

33. That the actions of the heart, lungs, &c. do not immediately cease, when those nerves are cut, is owing to this cause, that, although the par vagum be cut, and the supposed origin of the intercostals also, still the *intercostals* are *largely* supplied with *powers* from *all* the *spinal nerves*; *those nerves* will *continue* to receive supplies from the brain, so long as its functions remain; and, consequently, they must impart a *portion* of *those powers* to the *ganglia* of the intercostals; which, flowing to the lungs, heart, &c. will keep up the vascular actions there for some time; but, as the intercostals *alone*, are *not* sufficient to keep up the natural actions of those parts, the functions must *gradually diminish* in energy; the lungs will become loaded with blood; and death must ensue.

34. When the nerves are cut, the *refpirations* become laborious and unnatural, becaufe the æthereal and phlogiftic powers conftantly flowing to the par vagum from the brain, or nerves of motion connected with them, *cannot*, then, *flow* to the lungs and difcharge themfelves in vafcular actions; they, therefore, by means of the peculiar communication between the par vagum and the nerves which fupply the diaphragm and other mufcles of infpiration, *flow*, in a conftant ftream, to *thofe nerves* and *mufcles* of *infpiration*, which are, therefore, *excited* to *full* and *frequent action*, till the *want* of circulation in the lungs *deprives* the brain of its regular fupplies of æthereal air and phlogiftic blood, when its functions ceafe.

35. That the actions of the lungs, heart, &c. do not *immediately* ceafe, when the par vagum and intercoftals are cut, in the ufual manner, is owing to the *powers* communicated to the intercoftal nerves by the *fpinal nerves*, is *evident*, from the *inftant* death which follows the cutting of the *fpinal marrow*, where it leaves the cranium; for

then the *ſpinal nerves themſelves* have *no flow* of powers to communicate to the intercoſtals; neither have the nerves of the lungs, heart, or muſcles of inſpiration *any ſupply* of powers; in conſequence of which, their *actions* muſt *inſtantly ceaſe*; the blood muſt ſtagnate; and the brain being deprived of the excitement and powers imparted by the flowing blood muſt inſtantly loſe its functions and its life.

SECTION XVI.

On animal electricity, or the excitement communicated to the nerves by the application of metallic substances, &c.

1. MANY have been the experiments on this subject, by Galvani, the first observer of the influence, by Valli, Monro, Volta, Fowler, Wells, &c.; but as the effects proceed from the same principle, or cause, howsoever diversified the means of exciting them, I shall not enter into any minute detail of those experiments, but shall simply confine myself to such as are the most simple and constant; and, therefore, the most satisfactory and the properest to reason from.

2. If a nerve be laid upon zinc, and the muscle in which that nerve terminates be con-

nected with the zinc, by a golden probe, the muſcle will be agitated, as ſoon as the probe comes in contact with the zinc:—whether the nerve and muſcle be ſeparated from the body, or not, does not ſignify, if the vital principle ſtill remains.

3. The nervous powers, then, are excited to flow along the nerves, and that too by the metals; becauſe thoſe powers were quieſcent, and would have remained ſo, had not the metals been applied, or ſome equivalent, exciting cauſe.

4. If the nerve and its muſcle be put into water, near to a piece of zinc in the ſame water, and the golden probe be introduced into the water, ſo ſoon as it touches the zinc the muſcle is agitated.

5. It is evident, then, that water conducts this exciting power; conſequently, it is alſo evident, that neither the nerve, the muſcle, nor the metals, were in excitement *previous* to the appli-

cation of the gold probe; becauſe, if they were, the water would have conveyed that excitement from the one to the other, as well *before* as *after* the junction of the gold and zinc: and it is clear, to a demonſtration, that the exciting cauſe is *not* the *electric fluid*; becauſe, if the zinc, or gold, had been electrified before, the inſtant they had *touched* the *water* their electricity would have been *diſcharged*, without a poſſibility of bringing the two metals in contact, in contrary ſtates of electricity, in the water, which the conditions of the experiment require, ſince the zinc and the probe muſt come in *contact*, within the water, to produce the contraction of the muſcle.

6. That the effect in queſtion is *not* produced by electricity, then, is certain: in fact, no man can duly attend to the circumſtances of the two, and admit even the poſſibility of their being the ſame principles, in ſimilar ſtates of excitement; though every one muſt ſee ſo ſtriking a reſemblance, in ſome reſpects, as to feel no difficulty in admitting, that they may be the *ſame* principles, in *different ſtates* of excitement.

7. If zinc be applied to the nerve, it may be again withdrawn, without producing muſcular agitation: if gold be applied to the muſcle, it may again be taken away, without any apparent effect on the muſcle; neither of them, then, *ſingly*, excites the nerve or muſcle, ſo as to produce agitation.

8. If the zinc be applied to the nerve, and the gold probe to the muſcle, ſtill there is no agitation of the muſcle;—but, apply the metals to each other, and the muſcle is agitated:—by the contaction of the metals, thus connected with the nerve and its muſcle, then, the nerve is excited to agitate the muſcular fibres in which it terminates.

9. But, nothing is communicated:—if the metals be connected with the nerve and muſcle, by means of water, or any conductor of the electric fluids, or by a metallic chain, ſtill the muſcle is agitated when the metals come in contact, although no electric appearance can be perceived; neither can the moſt ſenſible elec-

trometers discover the least appearance of electricity :—had the metals communicated a flow of any kind of fluid, similar to the electric fluid, it would have been discoverable; but, no such thing can be perceived, neither is the state of the metals altered, with respect to electricity, by being in contact, from what they were before.

10. Besides, the nerve is a conductor of electricity; if, then, the zinc were *electric* with one kind of electricity, and the gold with the contrary, so soon as they were applied to the nerve and the muscle, they would *discharge* themselves *along* the *nerve*, and agitate the muscle, which they do not; unless the metals themselves be in contact.

11. We know, however, that when the metals are in contact, they cause the nerve to agitate the muscle, in the same manner as when the nerve is connected with the external coating, and the muscle with the inner surface of an electrified jar :—in the latter case, we know that the

nerve is excited by the contrary kinds of electric fluids rushing into combination, along the nerve, by which it becomes excited to agitate the muscle :—consequently, as the effect is the same, we must refer it to the same, or a similar cause.

12. Electricity, then, excites the nerve by the contrary electric powers, flowing in contrary directions, to combine with each other, along the nerves.—The excitement, by means of contrary metals, then, must be effected by the contrary powers, flowing in contrary directions, to combine along the nerves :—but, the metals had *no* such powers to communicate, as is evident from par. 9 and 10 :—the nerves themselves, therefore, possessed the powers, and the metals only *separated* and *excited* them, when *singly* applied; but, when they were brought into contact, they *destroyed* or *counteracted* each other's power of exciting the powers of the nerve, and *left* those powers, thus separately excited in the nerve and the muscle, to *rush along* the nerve, into *combination*; by which means, the *vital*

principle of the *nerve* was excited, to tranſmit its *powers* to the *muſcular* fibres, and throw them into action.

13. We have already ſeen (ſect. vi.) that it is an invariable law, that when the æthereal and phlogiſtic powers are made to change their ſtate, it is by *ſeparation*; and whatever *kind* of excitement is imparted to the *one* is, alſo, aſſumed by the *other*.

We alſo know that when any body is electrified with one kind of electricity, it will excite the common powers of any conducting body near it, to aſſume a contrary ſtate, or to form an electric atmoſphere of the contrary kind of electricity, not by communication, but ſimply by the attraction of the power forming the electric atmoſphere, to the contrary power always preſent, in ſome ſtate or other, in ſurrounding bodies; and we alſo know that when the conducting body, thus having its principles attracted and excited, is withdrawn from the influence of the electrified body, thoſe principles will *return* to

their *former ſtate*, by *diffuſing* themſelves equally over the conducting body; or, if the electrified body be diſcharged by the contrary electric fluid, the conducting body will *loſe* its atmoſphere *without* being *removed* from the electrified body, by the attraction *ceaſing* which ſeparated its powers and excited them.

14. It is evident, then, that the æthereal power when excited around one body, will attract the phlogiſtic power of another body within its influence, (13)—and it is equally evident, that when the phlogiſtic power is excited to any particular ſtate, the æthereal power which was combined with it muſt be ſeparated from it, and muſt aſſume a ſimilar ſtate.

15. Theſe facts, then, afford an eaſy ſolution of the experiments in queſtion.

Zinc has a natural attraction to *one* of the *powers*, in preference to the other; and gold has an attraction to the *contrary power*, which they

will, therefore, *peculiarly excite* at their ſurfaces.

Suppoſe that *zinc* attracts, or excites, peculiarly, the *æthereal* power, and *gold* the *phlogiſtic* power, naturally, and at all times, when circumſtances do not forbid.

If zinc be applied to a *nerve*, its excited *æthereal* power will have an influence upon the *phlogiſtic* power of the *nerve* :—for that the nerves do convey and contain *both* the æthereal and phlogiſtic powers, at all times, during life, I have already, in many inſtances, attempted to prove:—this attraction of the zinc, however, *ſingly* exerted, is not ſufficient to ſeparate and excite *both* the powers of the nerve, completely; for to effect that purpoſe, *both* the powers muſt be *attracted*.—If, then, the gold probe be applied to the muſcle, its phlogiſton will attract the *æthereal* power of the *nerve*; and by the *conjoint* influence of the zinc upon the nerve, and the gold upon the muſcle, or the extremities of the ſame nerve in the muſcle, it muſt follow,

that the *powers* of the nerve will be *ſeparated* and *excited*; the *phlogiſtic* power will be attracted towards the zinc, and the gold will attract the *æthereal* power, towards the muſcle, and by that means, the æthereal power of the zinc, and the phlogiſton of the gold, will become perfectly excited alſo.

16. If now the gold be applied to the zinc, the æthereal power of the zinc will, by contaction, immediately attract the phlogiſtic power of the gold; in conſequence of which, each will *loſe* its attraction to its reſpective *power* of the *nerve* :—thoſe powers will immediately ruſh in contrary directions, to *combine*, along the nerve; the phlogiſton of the nerve attracted by the zinc will ruſh towards the muſcle, and the æthereal power excited by the gold will flow from the nervous extremities in the muſcle, to the trunk of the nerve itſelf; by which means, the *equilibrium* of the powers in the nerve will be *reſtored*;—but, by that rapid *motion* and combination, the *animating* principle of the nerve will be *excited*: the conſequence of which is, a *flow* of

the *two powers*, by their reſpective nervous fibrillæ, to the *material* principles in *muſcular* arrangement; which, by that means, are thrown into action.

17. Whether the excitement, therefore, begins at the muſcle or the nerve, is the ſame in effect, as the two powers flow in *contrary* directions; and whether the zinc be applied to the nerve or to the muſcle, is of no conſequence, as the influence is ſtill upon the nerve in both places, and *both* the powers are there.

18. If water be interpoſed between the zinc and nerve, or the gold and muſcle, ſtill the effect is produced; becauſe every conductor of electric excitement is a conductor of *this*; the chief difference conſiſting in this, that in the electric excitement each power excites a *ſecondary*, or *external* atmoſphere of wide extent, but in this ſtate, the metals give a *ſimple excitement* to one principle in preference to the other, which is *not diffuſible* or *ſeparable* from the *metal itſelf*; neither is it ſo excited as to be capable of

acquiring a *secondary* atmosphere, at least so sensibly as to be evident to us.

19. It may be objected, that if the excited power of the metal is not diffusible, how then does it excite the nerve, when water is interposed, or other conductors, to such an extent as the metallic atmosphere cannot be supposed to equal?

The manner in which its influence is communicated is easy to explain; the zinc, we will again suppose, excites the æthereal power; every particle of water, like all other bodies in their common state, is attended by the two powers universally diffused.

If a conductor be charged with the electric fluid A, and a conducting body with its natural powers in an unexcited state be brought near it, the powers of that body will be attracted, separated, and excited;—the *approaching side* will have a part of its common principles in the electric state B, and the *distant* side

of the ſame body will have the other portion of thoſe powers in the electric ſtate A;—that body would then influence another, and ſo on, to any extent, if near enough to receive the progreſſive influence; and *that ſide* of every particle *moſt diſtant* from the charged conductor, would *always* have its principle in the *ſame* electric ſtate A, as the conductor itſelf:—conſequently, the *æthereal* power of the zinc, by influencing the powers in the water, will always attract the phlogiſtic powers of the particles of the water, *towards itſelf*, and the water will, therefore, act by this *æthereal* power upon the *nerve* oppoſed to the *contrary* or *diſtant* ſides of its particles.

20. As the powers excited by the metals in their common ſtate, are but *ſlightly* excited, any peculiar alteration, or change in their ſurfaces, may produce a change in their excitements; and different parts of the ſame metal may be ſo altered, by any local change of its ſurface, as to acquire a new power of excitement: and when the powers in the nerve are abundant, or the nerve is irritated by certain acrid applications,

its vital principle may be excited to tranſmit its powers by the ſlighteſt influence; and as the blood is always neceſſary to enable the nerves to produce muſcular contraction, when it is nearly exhauſted of its æthereal power, and the contractions ceaſe, they may be again reſtored, or they may be again augmented, by applying ſuch fluids, to the muſcles, as contain the æthereal principle, ſuch as the oxygenated muriatic acid.

21. That a metal may be changed in its peculiar attraction to one or other of the powers by friction with, or application to, certain other matters, is evident from experiment, and alſo from analogy; for moſt, if not all electrics per ſe, may be made to excite *either* the æthereal or phlogiſtic electricity, by means of *different rubbers*; conſequently, there is no difficulty in admitting that a metallic probe, or rod, which naturally is peculiarly attractive to the æthereal power, may be either wholly or partially changed, by the action of other ſubſtances, ſo as to have a preference for the phlogiſtic power,

22. This being the caſe, a ſingle metal rod may become both exciter and conductor.—For example, if a probe of zinc be rubbed by another ſubſtance of a different kind, for half its length, it may then have an excited phlogiſton on one half, and an excited æthereal power on the other half.—If the æthereal end be applied to a nerve, that æthereal power will ſlightly attract and excite the *phlogiſtic* power of the *nerve*, while the æthereal power of the nerve will be ſlightly excited alſo, and recede towards the muſcle: the excitation, however, is but *ſlight*, and the ſeparation *imperfect*; becauſe the æthereal power of the nerve is not *equally attracted* with the phlogiſton:—but, if the other, or phlogiſtic end of the probe be now applied to the muſcle, it will attract that æthereal power of the nerve in the muſcle:—the powers of the nerve, then, will be completely *ſeparated* and *excited*, and they, in return, will impart a *complete excitement* to the powers of the probe:—but, at the inſtant that the æthereal and phlogiſtic powers of the probe receive this active excitement, they *attract each other*, and counter-

act each other's excitement; and, consequently, *leave* the *powers* of the *nerve* and *muscle* to rush *together* along the nerve, into their usual state; by which *commotion*, the *vital* principle of the nerve is *excited* to transmit those powers to the *muscular* fibres, and cause them to *contract*.

23. All that is requisite, then, to this mode of exciting the nerves, while they retain their powers and vital principle, and the blood in the muscles is not exhausted of its powers, is, the application of two substances, or surfaces, *one* having a peculiar affinity to the *æthereal*, the *other* to the *phlogistic* power;—one must be applied to a nerve, the other to the muscle in which that nerve terminates, or to a different part of the same nerve itself:—they must be applied to those different parts immediately, or with the interposition of some perfect conductor of both powers.—Thus applied, the *one* will have a peculiar influence upon the *æthereal* power of the *nerve*, the other upon the *phlogistic* power; by this mutual and double influence, the powers of the nerve will be *separated* and instantly *ex-*

cited; by that means, *each* power will inſtantly exert its full influence upon the *contrary* power in the ſubſtance applied; and will, therefore, excite *it* to a ſtate of *perfect* excitement equal to its own.—In this ſtate, when the power of the nerve has fully excited the power of the ſubſtance applied to it, and the power of the muſcle has equally excited the power of the ſubſtance applied to it, if thoſe *two ſubſtances* be brought into *contact*, the excited phlogiſton of the *one* will then inſtantly *attract*, and *combine* with the excited æther of the *other*; by that means, their attraction to the ſeparated powers of the *nerve* will *ceaſe*; and *thoſe powers* will ruſh into *combination*, and excite the *vitality* of the nerve, to produce *muſcular* contraction, as before obſerved.

If the powers of the nerve be abundant, and the exciting ſubſtances be then *ſeparated*, at the *inſtant* of ſeparation, the contrary powers of the ſubſtances will again, ſuddenly, attract the *powers* of the nerves to their *extremities*; and by that ſudden *flow* of the *powers* of the

nerves in *contrary directions*, the *vitality* of the nerve will *again* be *excited* to throw the muſcles into action ; as is frequently obſerved, in trying the experiments.

24. Water, it is well known, readily tranſmits the influence of the powers of the metals and nerves to each other, ſo as to enable them to excite and attract each other; but water, as perfectly as it conducts thoſe influences, does not excite either the nerves or the metals ; water will conduct the influence from the nerves to the metals, when excited, but it cannot excite the nerves, becauſe it indifferently contains *both* the æthereal and phlogiſtic powers, and is *equally attractive* to *each* ; but to excite and ſeparate the powers of the nerves, it requires *two ſurfaces*, *one peculiarly* attractive to *one* power, and the *other* to the *other*.

25. Water cannot excite the powers of the nerves and ſeparate them, becauſe it is equally attractive to each power, and particularly ſo to

neither; but two metals may, if one be peculiarly attractive to one power, and the other to the contrary; becaufe, being applied to diftant parts of the nerve, they will *draw* and *excite* its *two powers* at thofe *diftant parts* of the nerve, from which they *cannot* return to *combination*, unlefs the *metals* be *taken away*, or the attractive powers of thofe metals be removed from the feparate powers of the nerve, by *attracting each other*. — Water may convey the influence of the feparate powers of the metals to the nerves, by which the powers of the nerves may be feparated, becaufe thofe powers of the *nerves* are *moveable*; but water cannot convey the *power* of *one metal* to the *other*, becaufe *thofe powers* are peculiarly attracted, excited, and *detained*, by the principles of the *metals themfelves*; in the fame manner as the *magnetic* atmofphere is infeparable from iron, and not conveyed by water, which water ftill readily conveys the contrary atmofpheres of thofe powers in an *electric ftate*.

26. The nerves, then, contain the æthereal

and phlogiſtic powers: when two ſurfaces are applied to diſtant portions of a nerve, *one* of which ſurfaces is capable of attracting the *æthereal*, the *other* the *phlogiſtic power*, in particular, the two powers of the nerve are ſeparated and excited, and in thoſe ſtates of ſeparation and excitation, communicate in return, a *higher degree* of *excitement* to the powers of the different *ſurfaces* by which they were ſeparated; in conſequence of which, the *æthereal* power of the *nerve* is *fixed* by attraction to *one* exciting ſurface, the *phlogiſtic* power to the *other*.

In this ſtate, if the contrary exciting ſurfaces be brought into contact, their *reſpective powers*, thus excited, will immediately *attract* each other; and by that means the powers of the *nerve* being no longer *detained* by thoſe ſurfaces, will ruſh into *combination*, along the nerve; by which rapid *motion* the *vital* principle of the nerve will be *excited* to tranſmit its powers to the *muſcular* fibres, and thus produce the *muſcular agitations*, which are the ſubject of inveſtigation.

27. The phenomena of animal electricity, as it is called, then, are produced by the same æthereal and phlogistic powers as constitute electric atmospheres; only they are in *different states of excitement*, and not formed into atmospheres attracting *secondary* atmospheres around them, as is the case when they are excited to become electric.

The nerves, we have formerly observed, do not convey or contain the powers in an *atmospheric state*; and the metals which are employed as exciters, peculiarly attract their respective powers, from which they are *not separable*, and which they do *not excite* to the *atmospheric* state; in consequence of which, they are peculiarly adapted to act upon the powers in the nerves, by a simple and mutual communication of influence, as being in nearly similar states of simple excitation: and the contraction of muscular fibres by common electricity, and by this metallic excitement, differ in this respect, that in electricity the contrary electric fluids are *communicated* to distant parts of the nerve, and rush in contrary direc-

tions to combine along the nerve, while in this metallic influence, the *powers* of the *nerve itſelf*, which were *ſeparated*, by contrary attractions to *diſtant parts*, ruſh into *contact*, by becoming *diſengaged*, in conſequence of the contrary powers which attracted and ſeparated them, withdrawing their attractive influence from the powers of the nerves to attract each other, when immediately in contact: ſo that electricity excites the vital principle of the nerves, by the rapid flow of the *foreign* electric powers; but in this metallic excitement, the vital principle is excited by the rapid flow of the *powers* of the *nerves themſelves*, to regain the *equilibrium* which was *deſtroyed* by the metallic influence. In both caſes the *motion* of the powers excites the *vital principle* of the nerves to tranſmit the æthereal and phlogiſtic powers, by their reſpective nervous fibrillæ, to the material particles in muſcular arrangement; where, by exciting the powers in the blood, thoſe particles are attracted towards each other; the muſcular fibres they form are ſhortened; and the two powers combining at the inſtant of their

discharge into the blood, form fire, which diffusing itself in the blood, constitutes the *heat* which is constantly generated by muscular action during life.

28. The reason why neither mechanical stimuli, nor the metallic exciters, produce motions of the *involuntary* muscles, by being applied to the involuntary nerves, may be easily seen, by only considering that the nerves which are distributed to the parts whose actions are *involuntary*, are *expanded* upon the *surfaces* of the extremities of the *blood vessels*, in the state of reticulated, or medullary *plexuses*; and that it is from *those plexuses* that the nervous fibres are sent to the *muscular fibres*; consequently, an excitement given to an involuntary nerve, can proceed *no further* than this *peculiar expansion*; and to produce the *action* of those involuntary muscles, the powers in these *nervous expansions, themselves,* must be *excited,* before they can be made to flow to their respective muscular fibres, and cause them to contract.

Having thus paſſed through the ſubjects I had propoſed to myſelf for inveſtigation, but in a much more ſlight and extemporaneous manner than I at firſt intended, I ſhall now lay down my pen for the preſent.—I have attained my object in writing, in the amuſement which the inveſtigation of my ſubject has afforded me, and I offer the ideas which have occurred, to thoſe who may be diſpoſed to attend to them.

FINIS.